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Engineering in the Commonwealth

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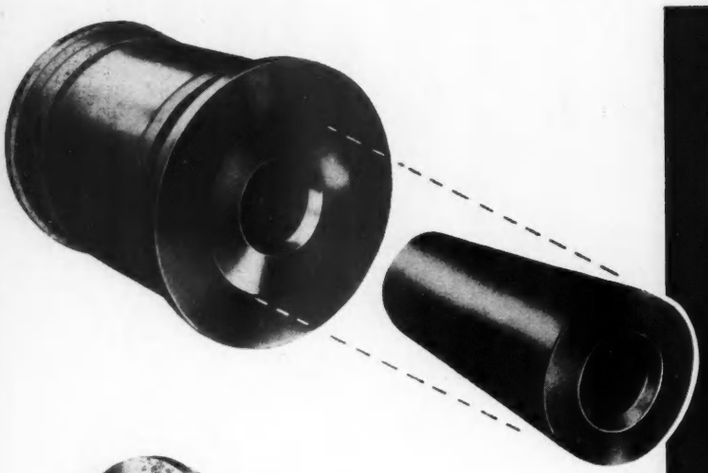

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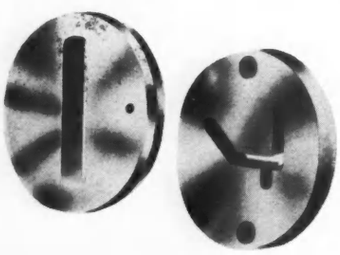

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26 May 1961

Vol. 191 No. 4962

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone: Temple Bar 3663

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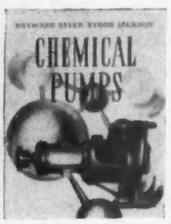

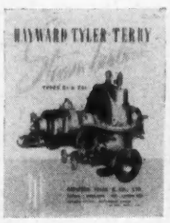

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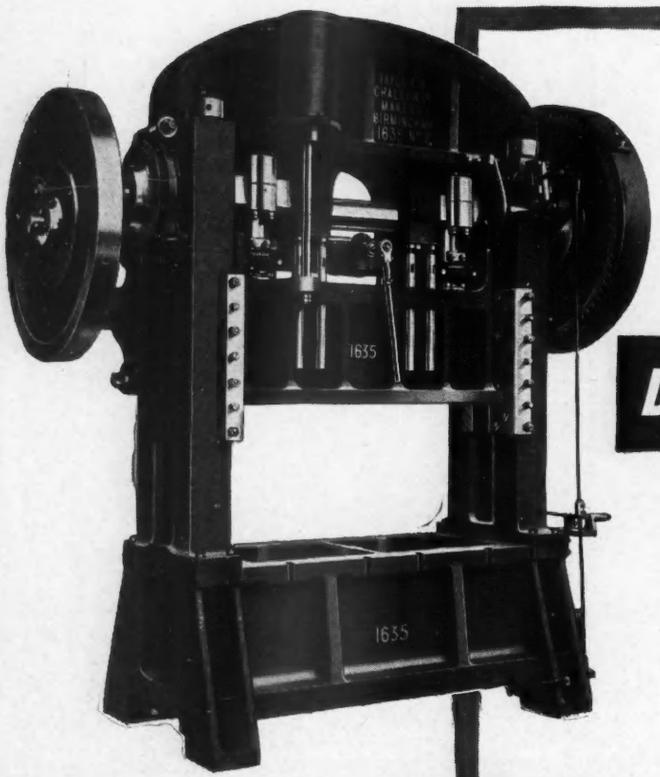

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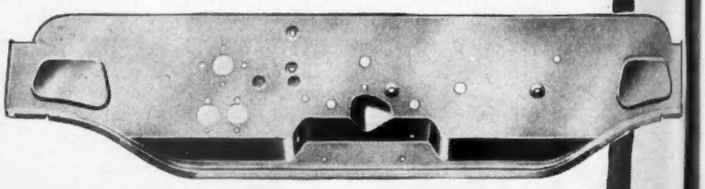

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ENGINEERING Impact

Of Anglo-Soviet Trade: A Two-way Affair

CAN the British Trade Fair in Moscow lead to Britain buying more goods and raw materials from the Soviet Union?

The question is not as Irish as it sounds. Anglo-Russian trade is the subject of official agreement and without major changes in the level of purchases by one partner to the trade pact there cannot be more than modest movements by the other.

For this reason, however great the impact of the Moscow Fair on the Soviet citizen, and all the indications are that it should be considerable, it will not be possible to change two basic conditions. The Russian trading structure by which major departments such as Stankoimport centralize much of the business into a relatively few hands and the second factor, that of the amount of scope provided by the ruling trade agreement.

The prospects of greater British purchases from the USSR are good in parts, not so good in others. In terms of simple volume of business the largest change would come if the British Government conceded the Russian wish to export quantitites of their oil surplus to this country. This hardly seems a political probability.

But there is the fast moving world of chemical engineering and it is more than likely that chemicals and techniques will tend to move in both directions. While the British machine tool makers go on improving their overseas order book there is still room in the British market for new arrivals in imported machine tools, sometimes able to do a special job and entering at a spectacularly competitive price. The Russian space successes suggest, too, that in time Anglo-Russian trade in electronics and instrumentation should by no means be one way.

The recent appearance of executives from the regional councils of the USSR in dealing with visiting salesmen could be an indicator of a swift acceleration ahead.

The Need for More and More Research

A SURE and certain way to technical degeneration and eventual eclipse . . .

This unnerving prospect was conjured up by Dr. Lawrence Pilkington, the research director of Pilkington Brothers, the great glass firm, at a recent advance look round their new £2 million research laboratories.

Dr. Pilkington was explaining that, for the industrial company, the choice was between leading the world by successful research or reliance upon buying the results of other firms' works. The price for the second course was always high and even prohibitive.

Such a fate is one which Pilkingtons have manifestly defied over a long period. They have consistently been leaders in plate and float glass, and since it is not possible to lead everywhere at once they bought ideas in sheet, pressed, optical and pressed glass production.

The new purpose built laboratories are to provide accommodation for 500 employees, 150 of them graduates, and all striving to keep Pilkingtons in front in its chosen fields in glass technology. First decisions for the new laboratories were taken six years ago, urged on by the sharpening competition from the United States, the USSR and other industrial states.

Will Pilkingtons find 150 of the right graduates for their research centre? On this Dr. Pilkington acknowledges that the shortage of scientists and skilled technologists persists in Britain.

As befits what may be the outstanding research centre in glass in the world, the Pilkington centre has a "window" of its own which may bring a quite new look to buildings and shop fronts. This is a three-storey glass wall, with no interruption from other parts of the construction. The biggest glass wall in Europe, it weighs 7 tons, is suspended from above, and should go a long way to keeping degeneration and eclipse away from the British glass industry.

Rising Tide of World Manufacture

THE fate of such productions as the most recent *United Nations Statistical Year Book*, with its wealth of comparisons between 1959 and years even further back, may be thought by the cynical to be no more than one of sitting on the shelf. In practice, even a swift look through the United Nations' publication shows how certain substantial trends in the world's post-war economy underline the beliefs of some important schools of thought in the direction of British industry.

Those who hold that the key to Britain's active industrial future lies in the development of capital goods are supported by the manner in which manufacturing output is seen to be rising all round the world, particularly in the swift increase of 1958-59, which followed the recovery from the recession in the United States and the accelerating growth of many of the other parts of the world. Increased industrial activity carried 1960 up to a post-war record. If information from the USSR, Eastern Europe and China were to be added there is no doubt the global total would look even more impressive.

By 1959 the manufacturing output of the world had reached 2·6 times that of 1939 and was 8 per cent above the previous peak year, 1957.

Apart from special causes which held the base metals industry back, every other manufacturing industry reached record levels of output in 1959. Measured over the period 1948 to 1959, chemicals (which for this purpose include coal and petroleum products) increased by 148 per cent, metal products by 97 per cent, non-metallic mineral products by 68 per cent, food, beverages and tobacco by 53 per cent. The slowest rate of expansion of all was found in textiles, whose post-war increase is of only 43 per cent—a reflection in part of the difficulties encountered by the United Kingdom industry.

Of long term significance, and perhaps not so very long, is the rapid rate of increase outlined in the regions of India, Pakistan and other east and south-east Asian states, excluding China. There, a 220 per cent in industrial production from 1948 to 1959 is recorded, with a 1958 to 1959 increase of 19 per cent. Starting from a relatively low base the metal products industries increased by 667 per cent. All other production totals show improvements, down to textiles, which went up by 145 per cent.

of Industrial Output's Failure to Increase

THROUGHOUT the past year industry has been toiling away modernizing its plant and equipment, building new capacity and extending existing factories—and now the Treasury's provisional figures show that for the first quarter of this year industrial production was on average the same as that in the first quarter of 1960. Nor do the provisional figures suggest that after a quiet January and February output from industry was beginning its long awaited climb during March. The adjusted index of industrial production for the first three months of the year (1954 = 100) was January, 119; February, 120; March, 120.

April 1960 produced a small two point rise, although the results fell back again marginally until last November the index was down to 119.

If the opportunity is given later this year to the motor manufacturers to keep more of their capacity at work than was possible last year, and if the much needed expansion in exports arrives, then this tendency to stay only a little way above the level of six or seven years ago may be overcome. Once the movement upwards is begun—if the Government can keep its hand off the brake—it may move with the speed of the German or Italian economic advances.

There is no sign yet of the big forward movement in exports in the April trade figures, where the excess of imports over exports was reduced well below the usual, to £24 million (provisional) partly by the delay to imports caused by the London dock strike (this will appear in later months) and also by the sale of the "Empress of Canada" and a naval vessel to India.

It is a little defeatist to look at these two ship sales and deduce that but for them the trade gap would have been its usual foreboding self. Instead it is possible to see what a difference to the trading results of the country the shipbuilding industry could make if its share of the world's new building was increasing and prospering.

At least one visiting American has recently paid admiring tribute to our salesmanship in getting the United States to drink gin and tonic; others have pointed out that Britain has the salesmen but needs to "put the goods in their hands". It sets off a completely new puzzle when the industrial potential is created but the exports fail to rise.

Coming Rise in Steel Prices

GROWING concern in the iron and steel industry at the position brought about by its increasing costs have led to the British Iron and Steel Federation deciding to repeat its request to the Iron and Steel Board for authorization of a significant increase in iron and steel maximum home prices.

Meeting in London last week the Federation's executive committee reviewed the earnings position of the industry and particularly the effect on the companies, now heavily committed to capital investment schemes, of the heavier cost burden from coal prices, electricity and other charges, wage awards and the estimated effects of the Hydrocarbon Oils Duty.

Maximum steel prices are fixed by the Government-appointed Iron and Steel Board, who have not yet granted higher prices to meet the rising costs. To this extent the steel industry is at a disadvantage compared with private industry and the nationalized undertakings.

From last September, when increased coal prices were imposed, there has been a £40 million rise in the costs of the industry. Making allowance for earlier savings accomplished, the overall cost increase of the last year has been equal to about £30 million—or more than 30*s* on each ton of finished steel.

The inevitable result has been steadily increasing strain on the earnings of the steel companies, at a time when they are spending a total of over £200 million on capital developments this year.

Iron and Steel Additional Costs

	Annual cost to industry £ million
Coal and coke Increases (Sept. 1960) ..	12·0
Consequent increases: (*a*) In electricity charges ..	2·5
(*b*) Other materials and services	4·5
Wage awards (Since November)	11·5
Road haulage rates (November) ..	1·0
Increased insurance and pension contributions (1 April)	3·2
Hydrocarbon oils duty (17 April), estimate	7·0
TOTAL since September 1960 ..	£41·7
LESS Reduction in imported ore prices in mid-1960, savings from that reduction and other items	£12·4
NET COST INCREASE	£29·3 millions

Comparison of UK with Foreign Home Trade Steel Prices

	Open Hearth Steel						Basic Bessemer Steel					
	UK			USA			Germany			France			Belgium		
	£	*s*	*d*	£	*s*	*d*	£	*s*	*d*	£	*s*	*d*	£	*s*	*d*
Billets	32	5	6	38	17	0	38	17	0	27	14	6	33	3	6
Joists	38	15	0	53	1	0	44	10	0	35	12	0	40	2	0
Plates (ship)	44	17	0	51	1	0	54	19	6	†51	7	6	†60	14	6
Rails	40	7	6	48	8	0	*46	2	0	39	3	0	45	16	6
Bars	39	10	0	54	1	0	45	18	0	35	15	6	39	12	0
Sheet	51	16	0	59	13	0	67	17	0	57	11	0	61	16	0
Tinplate (per basis box) ..	2	14	9½	3	3	2½	4	1	3½	3	9	2½	3	15	11

* Basic Bessemer Steel † Open hearth

Engineering in the Commonwealth

As a prelude to Commonwealth Technical Training Week, ENGINEERING presents, through its usual departments and features, a panorama of engineering activity in Commonwealth countries outside the United Kingdom.

His Royal Highness delivering the Graham Clark Lecture at the Institution of Civil Engineering.

Extracts from the Seventh Graham Clark Lecture "The Engineer in Commonwealth Development" delivered on 13 April, 1961, before the senior engineering Institutions by the Duke of Edinburgh.

I AM going to take it for granted that it is generally accepted that development in the broadest sense is a good thing. I hope I can assume that mankind is better off with proper food, sanitation, housing and all the material comforts which modern science, engineering and industry can provide. I am not assuming, however, that this material development necessarily implies a higher standard of human civilization. This, I believe, depends upon qualities of the mind and spirit which are not directly related to material comfort and convenience.

The Role of Engineers

Given the need for development in the material sense it does not take a great stretch of the imagination to visualize the engineer's part in the process. There are, in particular, four ways in which the engineer can implement and influence development:—

1. By continually finding practical ways and means of applying scientific principles and discoveries in power, industry, transportation, communication and construction. This means that research establishments are needed in all the divisions of engineering so that practising engineers can apply the benefits of fundamental scientific research.

2. By the application of the latest and most efficient methods to individual projects. This means that practising engineers must have some way of keeping up to date.

3. By the careful administration, maintenance and improvement of the engineering complex. Building or developing some project from scratch may have a great many difficulties but maintaining and improving a project which has been in existence for many years calls for even more skill and administrative ability. Railways are an obvious example.

4. By the technical training and education of the next generation of engineers. This is very much the engineer's responsibility and whatever the rewards of practice may be nothing is more worthwhile in the long run than teaching the next generation.

Power Potential

. . . the Commonwealth proportion of world population is 24 per cent and the Commonwealth covers 23 per cent of the world's land area. Add to this the fact that 20 per cent of the world's land rainfall falls on, and 18 per cent of the 17 great rivers of the world flow through, Commonwealth countries. Finally, and most significantly, the production of energy by the Commonwealth is only 12 per cent of the world's production even though India and probably several others have doubled their output in the last five years.

. . . Looked at in this way it is obvious that there is a very real urgency to increase the energy production and distribution in the Commonwealth.

Resources of the Commonwealth

. . . In mining the Commonwealth produces only 12 per cent of the world's iron ore but more than its share of many other metallic ores. I have no figures for the manufacturing industries as a whole but it is significant that the Commonwealth produces only 11 per cent of the world's steel, 15 per cent of the aluminium and 11 per cent of man-made fibres.

If you take this in conjunction with the fact that in only five major Commonwealth countries do the manufacturing industries account for more than 20 per cent of the gross domestic product while at least in six countries agriculture and forestry account for more than 40 per cent of the gross domestic product, as well as the fact that we only produce 12 per cent of the world's energy, the picture comes into rather sharper focus.

The implication is that in agriculture, basic industries and energy the Commonwealth output is not in proportion to its area or population.

. . . The total resources of the Commonwealth are probably roughly in proportion to its size but this does not mean that the resources are evenly distributed. Each country has certain limiting factors and may lack certain raw materials but on the other hand most countries have probably got something which is needed or wanted by others. There is no absolute need for countries to be self-sufficient, the real need is for Commonwealth countries to cooperate in such a way that the people can enjoy a reasonable standard of existence and the chance to develop their talents and their resources for the common good.

Technical Training Week

. . . It is clear that our investment has not been as productive as it should have been; I believe this may well be due to the inadequacies of our educational system.

. . . It was with this situation in mind that the City and Guilds of London Institute agreed, at my suggestion, to run a Commonwealth Technical Training Week at the end of May and the beginning of June this year. There has been a most encouraging response from all Commonwealth countries and we hope very much that the Week's activities will attract the attention of young people, their parents and employers to the need for technically trained people and to the ways and means of getting that training.

. . . The significance of all this to engineers is that you cannot expect development and progress to be maintained unless you make sure that there are enough people in the next generation capable of carrying on your work. Only engineers themselves are capable of estimating what a nation's future needs are likely to be in graduates and technicians. Only engineers can decide what the qualifications should be in the light of the current state of engineering development. Only engineers who have themselves been properly educated can begin to impart the necessary knowledge into the next generation. It is not simply a matter of maintaining standards of knowledge and conduct, it means that you are ultimately responsible for the material well-being of your fellow citizens.

The Target

. . . The target we should set ourselves in the Commonwealth is a reasonable material standard for all its people and the main responsibility for reaching that target will rest on the engineer.

That, in the end, is the engineer's contribution to Commonwealth development and it is my hope that the engineers of the Commonwealth will work together to reach that target in a spirit of trust and friendship.

Special Article

UK Engineers in the Colonial Territories

After a recent visit to East Africa, and Nigeria, the author concludes that the Colonial Territories require a new organization, based on the United Kingdom, to provide professional engineers who can help them to develop after achieving independence.

By J. G. Orr, M.A.(Cantab)

Secretary, The Engineers' Guild

THE problem of retaining British expatriate engineers, where they are needed in the public service of a Colonial territory after it has become independent, is one of the most crucial facing countries such as Tanganyika at the present time. To devise a way by which this can be achieved is a task which also intimately concerns the United Kingdom Government.

During April I went to Africa on behalf of the Engineers' Guild, visiting Nigeria, Kenya, Uganda and Tanganyika, in order to discuss these and other problems with members of the profession at first hand, and to meet as wide as possible a range of persons concerned with the employment of professional engineers in these territories.

The nature of the problem can be expressed quite simply in three statements: (1) there are at the present time some 600-700 professional engineers in Kenya, Uganda and Tanganyika, virtually all of them qualified in and recruited from the United Kingdom; (2) there is a serious risk that a substantial proportion of these will wish to retire when the territories become independent or within, say, one year afterwards; and (3) there appears to be no possibility whatever of their being replaced by qualified African or Asian successors for a good many years to come.

AFRICAN FEELINGS

The African feels that the achievement of political independence must be reflected increasingly in the staffing of the higher government posts, and in due course especially those at the very top. In order to " build up a viable local Civil Service which, with the assistance of some expatriate staff, will be able to carry the burden of administration when Uganda becomes independent," the Uganda Government have this year announced new proposals for the accelerated promotion of Africans into positions of responsibility.[1] At the same time the report refers to the rapid expansion of economic and social services in the territory since the end of the war, and goes on to state quite bluntly, " inevitably, these services have had to be staffed and administered very largely by expatriate officers, because the number of qualified local officers coming forward from the educational system has been wholly inadequate to meet the demand for qualified staff."

Unfortunately hard facts often make bad political capital, just as hard cases make bad law. The question today is whether the political climate can be guided and controlled by the responsible national leaders so as to allow sufficient time for the education and training of Africans in the various professions.

Some indication of the time required, in territories where the introduction even of Higher School Certificate education for Africans is of very recent origin, is given in another recent report, by Sir Richard Ramage:[2] " (The Cambridge School Certificate standard) provides the essential basic mind-training on which further training, including higher education, must depend and requires a period of twelve years of education. To qualify for entry to a graduate course normally takes two more years of general education, while the graduate course takes a further three or more years, according to the subject. This gives a total of not less than seventeen years from the start of education to graduation. On completing the graduate course, the man or woman is not qualified at once for a senior, responsible post. They have the knowledge on which to build up experience, and it is the latter which makes a person competent to discharge major responsibilities. The gaining of experience is, again, a matter of time. These considerations are not peculiar to Africans; they apply with equal force to Europeans and to every other race."

THE ENEMY

Lest the case for patience and a restrained approach to Africanization seems self-evident in the light of these facts, it is worth mentioning that while I was in Tanganyika a leading official in the principal political party was quoted as saying publicly, " We have one common enemy —the British." To this, Chief Fundikira, the Minister for Lands, Surveys and Water, promptly replied in a speech at the St. George's Day dinner, " Despite what you may have heard to the contrary, the common enemy of the people of Tanganyika is not the British. The common enemies are poverty, ignorance and disease."

The emphasis which I have placed on creating conditions under which British engineers will be enabled to stay in these territories after independence, instead of on the form and amount of compensation which they should be paid when they go, is deliberate. To plan for wholesale withdrawals is a policy of despair, because they must be accompanied by a lowering in the operational efficiency of the essential services for which the engineers are responsible, and could in fact lead to the services breaking down completely. It is as much in the interest of the officers concerned as it is of the independent governments, quite apart from that of the United Kingdom, for as many as wish to do so to remain.

The problem will not be solved, however, by introducing compensation schemes under which lump sums are paid by instalments over several years, as has been done in the case of Sierra Leone and is now to be applied in Tanganyika. The officers concerned are quite naturally sensitive to any suggestion of economic pressure to force them to remain, but the fundamental objection to this approach is that it does not attempt to deal with the real difficulties. There is at the present time a crisis of confidence—confidence in the United Kingdom Government and colonial administrations, and confidence in the responsible or potential governments of the territories themselves. In addition there is the basic problem, now widely recognized but to which no solution has yet been worked out, that political developments have put an end to any prospect of the expatriate officers being able to complete the careers for which most of them originally accepted appointments in the Overseas Civil Service.

Confidence is something which grows slowly but can rapidly be dissipated. Each time that a national leader allows himself on some public occasion to be tempted into glib references to " sweeping the British out of Africa " he makes it less likely that any belated effort to persuade some of them to remain will be successful.

Confidence in the United Kingdom Government has also declined to a serious extent during the last five years. This seems in part to be due to the way in which political developments have been handled, and in part certainly to the way in which the relative financial position of the officers was allowed to deteriorate. The report of the Flemming Commission in 1960 recommended increases of between 25 and 30 per cent in the total salaries of public service expatriate officers, which have since been approved by the territorial governments, and the fact that increases of this magnitude had become justified speaks for itself. So far as the future is concerned, there is an underlying fear that in the last resort the interests of expatriate officers might be jettisoned by the Colonial Office, if political expediency so required, and while this fear is probably unjustified and may well be unreasonable, it is not difficult to see how it has grown up.

Overshadowing all these considerations, however, is the problem of the future careers of the professional engineers in East Africa. The pattern has been set, and though it may be many years before they can be replaced by qualified nationals of the three countries, there are few who could look forward with confidence to achieving normal promotion and an unbroken career. An engineer aged forty, who has a family to maintain and children to educate, may well feel that if a break is inevitable and a new career must be sought, then the sooner it is made the better. I think this is why the compensation schemes in Nigeria have failed in their object to retain sufficient expatriate staff, and I doubt whether any other scheme that does not provide an answer to this problem is likely to prove successful in the long run.

ONE WAY

There is only one way, I believe, in which the interests of the expatriate officers can be reconciled with the needs of the territories in which they are employed, and that is through the formation of a United Kingdom based organization from which officers could be seconded to overseas territories as their services are required. The idea is not a new one and is in fact being applied on a very limited scale at the present time by means of short-term secondment, for example from the GPO to certain Posts and Telegraphs departments.

Any more comprehensive scheme was, rejected by the White Paper *Service with Overseas Governments*.[4] On the other hand it was strongly supported by the Select Committee on Estimates in its recent report on the Colonial Office, and a possible framework within which such a scheme might be developed was provided by the Prime Minister's announcement in March that a new Department of Technical Cooperation is to be set up. How the scheme would work, and how the evident difficulties could be overcome—notably that of guaranteeing continuity of employment and reasonable career advancement—are matters beyond the scope of this present article. Nevertheless, I am convinced that the effort is worth making, and that if successful it would provide the most constructive investment not only for a substantial share of the funds which the United Kingdom is granting to the newly-independent countries in the Commonwealth, but also of the skill and experience available among the professional engineers who have made their careers in the Overseas Civil Service of the Crown.

References

[1] *Future Developments in the Public Service of Uganda*, Sessional Paper No. 2 of 1961.

[2] *Report on the Localisation of the Civil Service in the Non-Self-Contained Services of the East Africa High Commission and in the East African Posts and Telecommunications Administration, 1961*, by Sir Richard Ramage, C.M.G.

[3] *Report of the Commission on the Public Services of the East Africa Territories and the East Africa High Commission*. Government Printer, Entebbe, Uganda. 1960.

[4] *Service with Overseas Governments*. Cmnd. 1193. H.M. Stationery Office. Oct. 1960.

Taking Care of Any Kind of Pipe Motion

Providing for thermal expansion in pipelines is a problem which has existed since pipes were first used. A Canadian firm offers a range of expansion joints to fit and forget.

AT ONE time the only method available to the engineer to overcome the problem of pipe expansion was by bends and loops, which were bulky and expensive to install. Today, methods are more refined, and expansion joints are capable of withstanding the higher pressures and increased traverses that are required in modern pipelines.

From Canada comes an interesting range of bellows-type expansion joints which are said to take care of any kind of pipeline motion. These are known as Flexon controlled-flexing expansion joints and combine the normal corrugated pressure carrier with precision-mated neck and reinforcing or control rings.

The major advantage of this controlled type of joint is that each corrugation—because of the control rings—takes only its rated share of traverse, thus equalising metal stresses. In addition, the control rings carry the hoop stresses caused by the internal pressure of the pipeline, thereby lowering the stress level in the corrugated element. Besides this, the control rings lessen the risk of external damage to the pressure element.

Strength Analysis

Employed in the recognized standards of the ASA code for pressure piping is Barlow's formula,

$$P = \frac{2St}{d}$$

where P = allowable working pressure (lb per sq. in)
S = allowable working stress (lb per sq. in)
t = wall thickness (in)
d = outside dia of tube (in).

Flexon expansion joints are designed on the basis of a corrugated element, assuming the diameter d to be considered as a "curved tube" to which Barlow's formula is applicable.

The conclusions are based on the following assumptions:

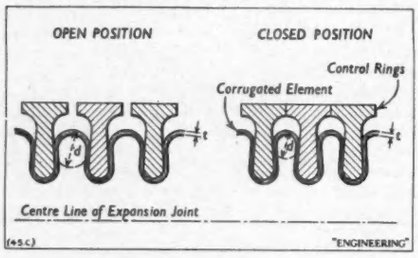
(*a*) The rings not only absorb the major diameter hoop stresses, but are positioned so that the "curved tube" dia d, for each corrugation, is constant throughout the expansion joint.

(*b*) At no time (in either position) can the corrugation base be collapsed, crushed or distorted.

(*c*) In the closed position, as per Barlow's formula, the wall strength of the unsupported part of the corrugation is equivalent to a curved tube of t wall thickness and of dia d as shown. (The dia of the expansion joint is of no importance as far as the strength of the pressure carrier is concerned, since the rings, not the pressure carrier, absorb the major dia hoop stresses resulting from internal pressure).

(*d*) In the open position, the "curved tube" formed, while slightly larger than in the closed position, is still controlled as to its maximum dia by the control rings, and is still subject to the formula, as described in the previous paragraph.

Each corrugation, because of the control rings, takes an equal share of the traverse, thereby lowering the stress level of the corrugated element.



Types of Movement

Pipeline movement may be divided into five basic types and Flexon joints can accommodate these as illustrated below.

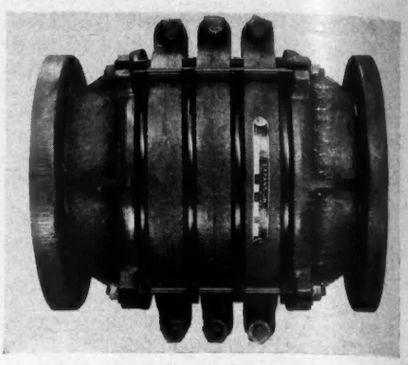
Axial movement.—This is the usual type of pipeline movement where all motion is in a straight line along the pipe. It should be said that rated traverse for standard units is for motion in compression only. For applications requiring motion in extension, the expansion joint needs to be precompressed by the amount of the required extension. Such an example is the installation of an expansion joint in a warm line where the joint will be subjected to axial extension when the line cools to its minimum temperature.

Lateral offset.—The type of pipeline movement where, on flanged pipes for example, the two flanges remain parallel and the same distance apart. The expansion joint must be installed in a partially compressed position to absorb lateral motion.

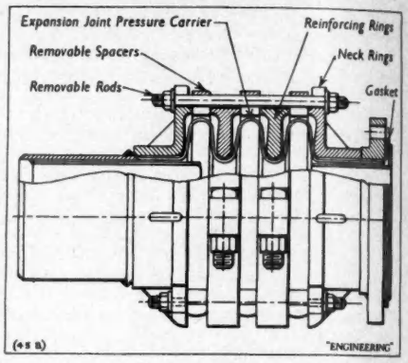
Angular rotation.—Pipeline movement where, to take a flanged pipe for example, the centres of the two flanges remain the same distance from a pivot point located half way between them when they are axially aligned. It also requires the expansion joint to be put into service in a partially compressed position.

Permanent piping misalignment.—The Flexon expansion joint offers a solution to piping misalignment problems. In these applications, where no motion is involved subsequent to installation, fewer corrugations may be used than would otherwise be required. Three limit rods are usually attached to the unit and provided with inside and outside nuts at both ends. Thus after a joint is installed, the misalignment corrected, and all twelve limit rod nuts are tightened, the joint becomes a semi-rigid part of the pipeline. When adequate anchoring becomes possible close to the joint, the limit rods may be dispensed with.

Vibration.—Selection of the most efficient device to solve this problem is dependent on a number of factors. (1) The amplitude, (2) frequency, and (3) direction of the vibration, in addition to (4) the internal pressure of the system. Flexon joints have worked satisfactorily in exhausts, blowers, diesel engines, compressors and similar installations.



Controlled-flexing expansion joints.

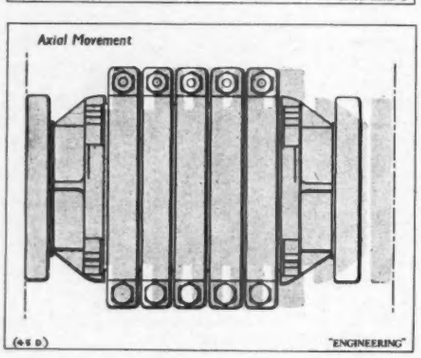


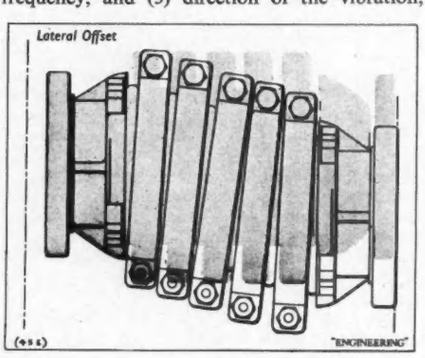
Flexon controlled-flexing joints take pressures up to 300 lb per sq. in (or 450 with special materials), and axial traverses vary from 4⅜ to 7½ in for the 3 and 10 in (and larger up to 24) nominal pipe sizes respectively. Maximum temperatures in copper are 406° F and in stainless steel 850° F. They are available with flanged ends or suitable for welding. Special joints for high pressures are available where problems cannot be solved with standard joints.

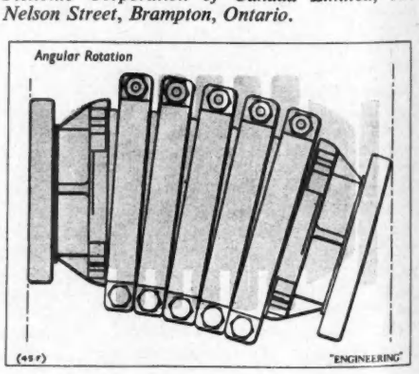
Special Units

Other units designed for special duties include; **Hinged** type expansion joints, used specifically where a self-restrained joint is needed to absorb angular motion (where flanges do not remain parallel under operating conditions. **Balanced Units** are designed for use where anchoring—normally necessary to restrain the end thrust of an ordinary expansion joint—cannot be provided. **Gimbal type** for use where a self-restrained expansion joint is needed to absorb angular rotation in any plane. **Universal type** capable of absorbing combinations of axial, lateral and angular movement.

Flexonic Corporation of Canada Limited, 134 Nelson Street, Brampton, Ontario.







Advanced Design Calls for Advanced Testing

Four prototype aluminium covered-hopper wagons have been undergoing an extensive test programme in Canada. Developed jointly by the Aluminum Company of Canada Limited and the Canadian National Railways (CNR) they have a capacity of 80 tons, which is said to be 10 tons more than existing steel ones belonging to CNR.

The increased payload enables nine aluminium cars to do the work of ten existing cars and maintenance costs will be considerably reduced. Designed on a 5 ft module, the cars can be built with capacities of 2,500, 3,000 and 3,500 cu. ft without greatly altering design or production jigs.

Curved sides give maximum metal economy and act as both column and girder, eliminating side posts, cross bearers and the part of the centre sill between bolsters. In conjunction with the eight discharge gates located centrally along the centre line of the car they give a smooth interior which simplifies unloading and cleaning.

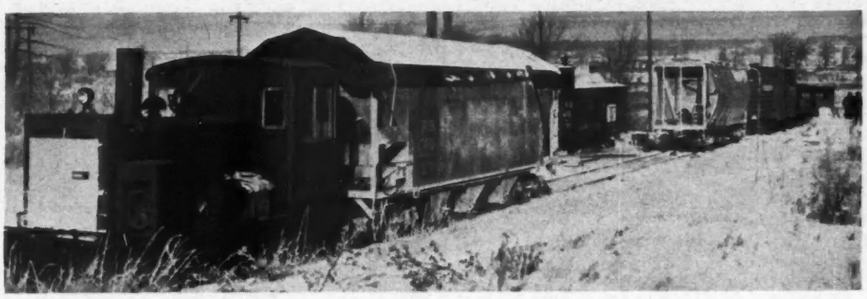
Because of the advanced design of the wagon it was considered essential that complete mechanical testing should be carried out on one of the four wagons as soon as possible.

One of the wagons was selected as a test car and about 50 strain gauges were applied at various points. After fixing the gauges and the associated wiring, the car was submitted to a static test where sand and alumina were used to represent two typical ladings with densities of approximately 100 and 60 lb per cu. ft respectively.

The impact tests were intended to reproduce the type of loading to which the cars will be subjected during coupling and hump yard operations. Impact forces were then extended beyond the normal range encountered in freight service. Impact loads have exceeded one million pounds at approximately 9 mph without failure. These tests were completely successful. The wagon was located on the test track with lead wires connecting the strain gauges to the oscillograph equipment in the caboose. The strike car, a 80 ton open hopper wagon loaded to 210,200 lb on the rail, was released from a point higher up the 3 per cent gradient to give varying impact speeds and impact loads on the dynamometer block which replaced the standard coupler on the covered-hopper-wagon. Immediately after impact the air brakes were automatically applied to restrain both wagons.

Having established the static and impact loads, the next step was to determine what additional alternating stresses would be applied to the movement of the wagon down the track. A series of road tests were carried out to record the alternating stresses at speeds up to 80 mph, and during the frequent impacts occurring in freight train operation during run-in and run-out. All recorded stresses were well below allowable design stresses. Oscillograph equipment provided a permanent photographic record in addition to a temporary visual indication at the time the strain was being recorded. Not only could an observer feel the severity of an impact during road tests but he could at the same time see the extent of the stress produced at any one of the gauges.

The second phase of the testing programme included a series of impact tests involving loads up to one million lb. The illustration below shows the test and strike cars just prior to impact.



Fatigue test of the car body and underframe was done by placing an oscillating jack under the centre sill of the wagon, removing the snubbers from the bogie and oscillating the car in a vertical direction at its natural frequency. Strains obtained by this movement were related to the strains recorded during the road test. The equivalent of 25 to 30 years' service life will be applied in the course of three months testing.

The fatigue tests were up to six million cycles without failure, early in May. The tests will continue to approximately ten million cycles when the equivalent of 25 years life will have been reached. An interesting result was the breaking of steel springs; this occurred about once every two days. The necessity of spring replacement delayed the completion of the tests slightly.

Three cars have been kept in constant use on unloadings. The principal loads were alumina, lime, salt, sand, cement, and adipic acid. The time required for unloading cement has been reduced from 18 to 4 minutes, principally because of the smooth flow shape of the hopper cars. Analysis of these tests will be a basis for determining the future practicability of this wagon design.

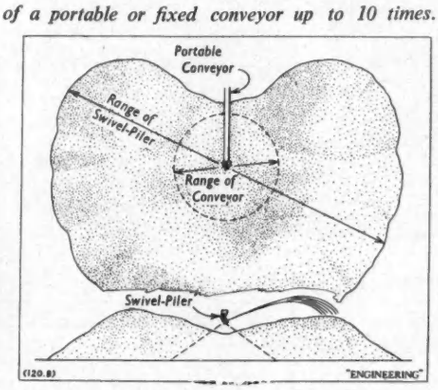
Alcan (UK) Limited, 30 Berkeley Square, London W1.

How to Increase the Storage Range of a Conveyor

A Swivel-Piler mounted on the end of a conveyor can, according to the manufacturers, increase the storage range at the end of the line over 10 times. It will throw material in any direction over an arc of 270° with capacities of up to 150 tons per hour.

An adaption of the centrifugal Car Loaders and Swiveloaders which S-A have made for filling trucks and large bins, the Swivel-Piler consists of a hopper with swivel joint, an S-A centrifugal thrower, and a remote control cable and swiveling crank. This equipment can be mounted as a unit beneath the discharge of practically any portable or fixed belt-conveyor.

A Swivel-Piler will increase the storage range of a portable or fixed conveyor up to 10 times.



The thrower consists of a short high-speed belt conveyor with the carrying surface held in a concave curve by side discs. A vertical spout drops the material between the discs, where it meets the curved belt—travelling in the same direction. The original momentum of the material is maintained and, as the belt and material travel around the concave curve, the momentum of the material is increased to that of the belt. As the belt passes over the front of the pulley the material continues at high speed and is thrown by centrifugal action from the unit.

The material stream can be directed while running and the trajectory can be raised or lowered from 8° to 40°. Normally the stream is adjusted vertically to suit the height to which the material is to be stored. The pile of material starts to form at the outer end of the trajectory, and as the pile grows the peak of the pile automatically moves back along the trajectory without any adjustment to the throwing angle.

Materials which can be handled vary from grain to small lump form. 10 and 16 in units are available.

Stephens-Adamson Mfg. Co. of Canada Limited, PO Box 397, Belleville, Ontario, Canada.

Diagonal Belts are Best in Car Accidents

Investigations in Australia and Sweden have shown that a much greater degree of safety in motor-car accidents can be achieved by the use of diagonal belts or chest straps rather than lap-belts.

By D. C. Herbert, B.Sc.(Eng.)(Lond.), A.M.I.E. (Aust.),
Snowy Mountains Hydro-Electric Authority

EXPERIENCE in Sweden and the United States has shown beyond doubt that the use of adequate safety belt installations reduces injuries and deaths significantly in motor accidents. This conclusion is based on surveys by the National Swedish Road Board and at Cornell University.

The surveys at Cornell showed conclusively that injuries in fatal and serious accidents could be reduced by 35 per cent and in all accidents by as much as 60 per cent. These surveys referred to American cars in which aircraft-pattern lap-belts were fitted. Investigations in Sweden and by the Snowy Mountains Hydro-Electric Authority in Australia have shown that much greater improvements can be obtained with other patterns of belt such as the chest strap and diagonal belt, and by employing improved designs, materials, construction and fitting.

As impact of the head is the main cause of injury, the designer of a safety-belt installation has to take into account the conditions under which head injuries are caused: these being by ejection of the body through the windscreen or doors leading, to impact of the head with objects outside the car, such as the road, trees, walls or vehicles; and by impact of the head with hard or sharp objects inside the car.

To prevent ejection, the belt must slow down the wearer in a safe manner after the vehicle collision, without failure of the belt or its anchorages. A properly designed and fitted lap-belt will do this in the majority of occasions. To prevent the impact of the head with the interior of the car, the belt must prevent the head swinging forward on to the instrument panel or steering column.

When a lap-belt is fitted for the front seats, it is very difficult to provide adequate clearance. For the head to swing forward freely, a clearance of 36 in is required and, to this amount, there must be added at least 9 in for belt extension, making a total of 45 in. Such an allowance is rarely available, even in the largest cars. If this clearance were provided, the head would swing down to strike its owner's knees with heavy impact and injury, and rotational acceleration would raise the speed of the head to a value appreciably higher than the original car speed. Contrary to some reports, the kinetic energy of this impact may be almost as high as the impact it seeks to replace, again, because of angular movement.

These are some of the reasons for the adoption of various forms of chest restraint in Sweden and by the Snowy Mountains Authority wherever practicable. This system is also being adopted in various European countries, including the United Kingdom.

There is good evidence to show that, unless the design studies of a safety-belt installation include criteria depending on the limitations of the human body to withstand rapid deceleration, the installation will not prevent injury under certain conditions. The design criteria should also take into account the fact that the body will readily accept restraints of specific nature and degree. Extensive research and experimental work to establish the tolerances involved has been carried out, notably by Stapp, Pesman and Eiband, Eiband, and Severy, and the tolerances are found to depend upon a number of inter-related factors: the duration of deceleration; the deceleration value; the deceleration time rate, sometimes referred to as "jerk," and the method of restraint.

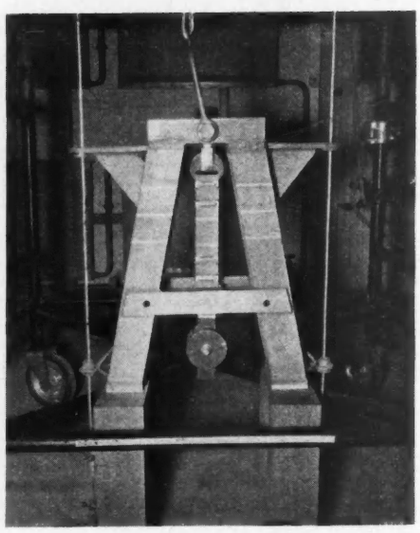
For a simple safety belt, typical maximum values in modern designs are 100 milliseconds, 40g and 3,000g per second, where g is the value of gravitational acceleration. A belt installation designed on these criteria will give excellent protection up to impact speeds of about 50 mph, and most accidents occur in this speed range.

Besides the basic design criteria, which are usually met by the proper selection of materials, particularly of the webbing, there are many secondary factors which may lessen the effectiveness of the installation.

In Sweden, the belt webbing is manufactured to give a specified relationship between load and deformation, and so provides all the protection required through considerations of human tolerance. It is sometimes argued that the crushing of the vehicle on impact gives much of this protection in the form of movement of belt anchorages, but the evidence available suggests that this is incorrect. Severy showed that in a typical collision, car deformation continued for 60 milliseconds before the body changed its attitude and that deformation was complete before the belt tension had reached its maximum value. A mathematical analysis by the author with a simple model in mechanics, has given a similar result, as have Swedish experiments.

Unless other means are provided to lessen the effects of impact, the webbing must stretch by an amount sufficient to increase the deceleration interval, and reduce the deceleration value and rate to the limits required by physiological considerations. At the present time, this protection can only be given by belt stretch.

Few writers on belt design have fully recognized the significance of belt stretch; yet, in the design of crash padding, it is considered fundamental to base the whole concept of protection on the deformation characteristics of the padding material to be used. It is easy to calculate from the typical design criteria already quoted that a belt stretch of at least 6½ in is required to give protection up to impact speeds of 20 mph, yet some specifications limit belt stretch to less than this value. For the design speed of 50 mph, the maximum deformation allowed in most specifications is too low, and no minimum is specified. The Swedish specification, which requires 35 per cent minimum webbing extension is a notable exception.



Dynamic test assembly used by the Snowy Mountains Authority for webbing. The webbing is suspended from a steel A frame and supports a weight, the assembly being dropped on to steel anvils while a camera records the impact at a speed of 3,000 frames a second.

At this point it is necessary to discuss the reasons governing the inclusion of a maximum extension as low as 25 per cent in a specification such as BS 3254: 1960, "Safety Belt Assemblies for Motor Vehicles," with no minimum value. The basic reason is fear that more stretch will permit the impact of the head with the car interior; but this point has already been dealt with by replacing the front seat lap straps—designed for aircraft—by chest or diagonal straps, now available from the majority of belt manufacturers in the United Kingdom, but not yet in Australia. There is no longer any reason for not adopting the Swedish webbing specification in most car safety belt designs.

The design criteria stated in the British Standard referred to are deceleration value 20g horizontally, and body weight involved 200 lb.

These criteria assume that protection is given to the majority by allowing for a very high—and improbable—body weight in the calculations. For a particular webbing, this is not correct, however, since in given accident conditions, deceleration values will be reduced as body weight is increased. The heavier the wearer is, the better the protection afforded by a belt. The greater belt tension produced by a heavier body is a separate problem.

Estimations of weight enable belt tension to be calculated for the 40g crash used for design purposes. The tension in this example is 6,000 lb, or 50 per cent more than allowed for in the British Standard, which uses a 20g crash for design. Future designs should provide belts which will give the wearer protection under the more severe accident conditions which, the evidence has shown, he can survive. Of particular interest in this connection are the Swedish belts which are designed for 50g deceleration of a 132 lb weight; accidents show that these belts (mostly of the diagonal type) reduce injuries significantly in 75 per cent of accidents in which they are used.

If the belt, after stretching during impact, were to act as a spring, it would return the wearer to his seat—provided the seat had not parted from its anchorages—at the original speed of the car. Dynamic tests were carried out by the Snowy Mountains Authority, and recorded by using a high-speed movie camera; these tests provided an essential check on the shock absorption properties of webbing, determined previously in conventional tensile tests in which the energy destroyed was measured during cycles of loading. The test assembly used is shown in the accompanying illustration. The Snowy Mountains Authority require that 60 per cent of the energy stored during loading shall be destroyed by the permanent stretching of the webbing.

This account has been prepared by the Snowy Mountains Hydro-Electric Authority following upon investigations and testing performed at their Engineering Laboratories at Cooma, NSW, Australia.

Photocopies of the complete paper, with a bibliography of 17 items, of which the foregoing is a digest, may be obtained from the Publisher, ENGINEERING, *36 Bedford Street, London, WC2, price 10s each, postage included. (Orders should be accompanied by the required remittance.) Duplicated copies may also be obtained, in Australia and New Zealand, from the Snowy Mountains Hydro-Electric Authority, Cooma, NSW, free of charge.*

Plain Words

By Capricorn

I HAVE become rather set in my ways. And so I fear have many of us. It is not so much because of habit, or even over cautiousness, but rather because of a tendency to calculate too much.

Calculation can be a form of indecision, or at least be so devitalising, clouding with detail the one paramount issue, that decision becomes dissipated. The bold clear impulse is discarded in favour of the politic, the dulled and calculated compromise.

But I know how hard it is. I remember, as a youth, I had taken a vacation job with an Italian firm of civil engineers, building dams, idylically, in the Dolomites. Being poor, I went by train, third class, catching the night express from Paris. I slept and in the first light woke to find a rather pretty girl sleeping on my shoulder.

We talked and watched the passing fields of France and Northern Italy all day. Her name was Geneviéve, after the patron saint of Paris. She was in her third year at the Sorbonne, reading English literature, and now was on her way alone to Ljubljana, from where she would hitch-hike southward to Athens. She asked me to come too.

In the day she shared her food with me and when the water in the carriages dried up she gave me Cologne to clean and cool my face. But I was calculating. What would the firm say if I didn't turn up, and Mario, who had been so kindly instrumental in inviting me; and there was the professional experience so essential to future institution membership. So at Padua, on to a very lonely platform, I alighted.

The Cologne stayed with my handkerchief for several days. And ever since I have regretted my decision. There is no consolation in pretending that my conscience or my sense of responsibility guided me.

And I fear my own weakness is today a common one. The young express their differences by foibles in dress, not by exposing themselves to the vicissitudes of life. Nowadays we don't set out for countries in the Commonwealth unless we have secured our pension rights. I know a young man who was offered an exciting job in a new African territory and turned it down because: "You can never tell, in a couple of years they may have a revolution, and we may all be out on our ears." So what?

It is high time we learnt to let go, to make our choices body and soul, to embrace the Commonwealth, and indeed the Common Market, wholeheartedly, making what sacrifices in pride and sovereignty that may be necessary, not fritter away our energies seeking formulae, until, as in the case of the Sibylline books, the price is astronomical.

For too much calculation will cripple us. As a friend of mine wisely observed to me some weeks ago when I was called upon to commit myself to an irrevocable step: "Whatever decision you take with conviction will be the right one, for by implementing it, you will be sure to make it right."

Letters to the Editor

National Use of Technical Information

SIR, I would like to refer to various parts of the essay on information work submitted as a letter to the Editor by Mr. B. T. Stern (ENGNG., 12 May '61, p. 653).

From Mr. Stern's letter one gathers by a process of collecting scattered statements that some of the functions of an information officer (or "information scientist" to use the term being sponsored by the Institute of the same name) include

(1) current searches,
(2) translating,
(3) editing research reports,
(4) abstracting,
(5) advising on patent law,
(6) typographical layout,
(7) lecturing and arranging tours and visits,
(8) sources of supply of specialized journals,
(9) collection, distribution, storage and retrieval of information, and, finally,
(10) pre-war consultant's work.

Now this is a formidable list. It is obvious that some of the functions included would, in a large organization, be the concern of various specialists, such as public relations officers, patent engineers or agents, typographers, and so on. I would suggest, furthermore, that sources of supply of specialized journals, collection, distribution, storage and retrieval of information are all (while touching closely on the work of the information officer) largely the province of the librarian who is there to provide these services to both information officers and other inquirers.

No one doubts that a wide range of borderline duties (including others than those listed above) can become the province of library/information staff, especially when attached to smaller organization units. This sort of thing is inevitable and the staff concerned—whether they call themselves by established occupational terms such as "librarian" or synthetic ones such as "information officer"—very frequently demonstrate a surprisingly wide range of ability.

What I do take exception to is that, while these tasks can apparently be performed by information officers, "librarians should not be asked to cope with them." Your librarian is quite capable of coping with indicative and in some cases informative abstracts. Considering that he spends much of his time building up indexes of various types he is also quite good at conducting searches; sources of supply of specialized journals are most certainly a primary part of his job as is also the collection and storage of information. Library Association examinations include requirements for a knowledge of typography.

I would hesitate to consult a normal librarian too deeply on patent law, equally so an information officer. Arranging tours and visits frankly leaves me a little puzzled but librarians should be expert in the use of timetables which presumably must help.

In my estimation, your librarian exists to provide a library service in the widest possible sense to a given establishment. This involves training and experience in indexing, storage, retrieval, bibliography, compilation and publication of bulletins and lists, circulation and issue systems, etc., knowledge of sources of information, handling inquiries and liaison with other services and sources.

Your information officer is specifically there to assess and annotate available information not only in formally recorded form (literature, films, sound records), but also by means of interviews with authorities.

Mr. Stern's statement that he is the post-war counterpart of the consultant, while possibly rather sweeping, does indicate rather more clearly than the earlier parts of his letter the relative function of the librarian and the information officer.

Yours faithfully,
B. J. S. WILLIAMS,
Chief Librarian,
Technical Information and Library Services.

Advanced Projects Group,
Hawker Siddeley Aviation Limited,
Kingston-upon-Thames.
16 May, 1961.

SIR, "As a result of their haphazard and uncoordinated development the abstract publications, though numerous, are far from covering the whole international field of technical literature in a uniform way."

So wrote Holmstrom 25 years ago and Mr. B. T. Stern's letter (ENGNG., 12 May '61, p. 653) suggests that no advance has since been made. Neither the Minister of Science nor the Department of Scientific and Industrial Research have any influence on the overlap of work. Again, Holmstrom wrote: "About one-third of all worthwhile articles are indexed or abstracted several times over in different media, while the remaining two-thirds are missed altogether," in which he quotes an Aslib conference report by Dr. S. C. Bradford of the Science Library.

Needed as much as coordinated work, is a spread of knowledge of what already exists, how to find and use it, and how to call for improvement in it. The DSIR publication *What They Read and Why* condensing a Central, Office of Information social survey report, which relates to technologists in the electrical and electronics industries only, observes: "... learned and professional societies ease the burden of technical literature ... by the publication of abstracts. However, only a minority of technologists [38 per cent] in these industries are aware of abstracts in their special field, and even fewer claim to make use of them [31 per cent]. Even among research workers, half did not know of abstracts in their field; 28 per cent could identify abstracts they had used; only 13 per cent among production supervisors."

Now those industries are reputed to have taken most advantage of recent science and technology. Is it the 31 per cent who did it or do we conclude that abstracts are superfluous? But, assuming that they have some worth, could they not be made more attractive, more quickly and conveniently usable, less like repelling auctioneers' catalogues; compiled, it is hoped, with less abandon of description?

While, in general, the compiling is done by technical specialists, there are cases in which it is not. That is apparent in them, just as it is apparent when a technical translator from foreign languages has tackled a subject in which he has little technical knowledge.

In the production, presentation and indexing of abstracts there is the great hindrance of indescriptive titles, so faithfully copied, so falsely filed. "As every researcher knows, unaided titles of articles frequently give a misleading indication of the contents," to quote Holmstrom again; and they do, more so every day. Esso Research, in the United States, seem to have studied this question and could well be emulated. In *Style and Speed in Publishing Abstracts* they present some better ideas, among which is one for running the title into the text; the title being not that of the article, but a composed concise topic phrase; a "container" phrase. Their abstracts aim at a maximum of 125 words; this allows the use of a larger type face than normal. The true title and reference, it is suggested, should be placed at the end. In fact, a study of reader convenience, which is what more articles should consider.

Readers, too, need to play their part. They do not criticise enough, or sufficiently voice their requirements and objections. Their criticisms should come in at regular agreed intervals, for consideration. Committee-directed abstracts can become unbalanced. Unprepared, the committeeman is asked what subject aspects he

wishes to see in abstracts. The problem uppermost in his mind, though incidental and not general to his industry, is tabled, introduced and thereafter never deleted. So, unbalance may grow. Were abstract selectors to do a thorough job, all their time would be occupied reviewing first the abstracts of other organizations than their own, before they reached the current literature. So selection has become arbitrary and quite unanalytical. State-of-the-art reviews are made little use of.

For indexing purposes, the useful continental practice, which overcomes bad titles, could be more widely adopted. They list UDC numbers to which the article relates; inquirers can than select the filing category most suited to them.

Why does all this need more active attention? Mr. P. S. Davison, referring to chemists, states in the May issue of *Research Applied to Industry:* ". . . chemists are known to spend 42 per cent of their time handling information." Chemists have used it most effectively in recent years, perhaps this is the reason. How do other industries compare? How can some of that time be saved?

Yours faithfully,
W. D. ARNOT.

Nuneaton,
Warwicks.
20 May, 1961.

Events in Advance

Engineering Institutions Aid Commonwealth Week

SEVERAL professional engineering institutions in this country have arranged to take part in the Commonwealth Technical Training Week, which, as our readers are aware, begins on Monday next, 29 May, and will continue until Sunday, 4 June. The week is being sponsored by the Duke of Edinburgh.

The Institution of Civil Engineers have organized a special programme for 300 boys of sixth-form standard at the Institution building, Great George Street, London SW1, on 30 and 31 May. The event is intended to provide boys who have expressed a general interest in engineering with an insight into civil engineering, in the hope that it will enable many of them to decide whether or not civil engineering is to be their choice as a career.

The main theme of the programme, which is entitled "Civil Engineering Works: from Inception, Through Design, to Completion," will be centred round a series of ten selected civil-engineering projects. So great was the response that the full quota of 150 boys for each day was completed by 10 March.

The Institution of Mechanical Engineers has arranged for senior members of their Institution to be available at their headquarters, 1 Birdcage Walk, St. James's Park, London SW1, each day, between 10.30 a.m. and 7.30 p.m., from 29 May to 2 June, to advise boys, parents and careers masters on the education and training of professional mechanical engineers. Appointments may be made by telephoning WHItehall 7476. The Institution will have a display of photographs and engineering models in the entrance hall of their building and, on 30 May, a number of technical films on engineering projects will be shown. Further details and tickets (gratis) are obtainable from the above address.

The Institution of Structural Engineers are staging an exhibition of photographs, models and drawings illustrating the profession of structural engineer at 11 Upper Belgrave Street, London SW1, also from 29 May to 2 June. This exhibition will be open daily from 10 a.m. to 12 noon and from 2 p.m. to 8 p.m. Members of the Institution will be available throughout this period to answer questions regarding training for the profession, and its prospects.

The above are but a few of the many ways in which the professional engineering institutions are cooperating in the Week.

Analytical Instrumentation in Industrial Processes

INCREASING attention is still being directed towards the implications of quality control on all phases of industrial production and this tendency seems likely to continue for years to come.

On 13 and 14 June, Elliott Brothers (London) Limited, a member firm of the Elliott-Automation group of companies, are holding a private symposium and exhibition on "The Analytical Instrumentation of Industrial Process Control" at the Connaught Rooms, Great Queen Street, London WC2.

Papers being presented will include "The Application of Analysis Instruments in the United States," by Mr. K. E. Hallikainen, president of Hallikainen Instruments of Berkely, California; and "The Continuous Measurement of Moisture," by Mr. D. J. Fraade, head of the applications laboratory of the analytical and control division of the Consolidated Electrodynamics Corporation, Pasadena, California.

Two other papers, entitled "Analysis Instruments from the Point of View of the User" and "Experience with Plant Steam Analysers at Imperial Chemical Industries, Billingham," will also be read. Mr. T. R. Mills, chief engineer of the analytical instruments division of Elliott Brothers (London) Limited, will speak about trends in continuous process analysis.

There will be on exhibition, during the period of the symposium, a wide selection of the extensive range of quality control instruments supplied by the analytical instruments division of Elliott Brothers (London) Limited. Additional information is obtainable from Mr. John Geddes, Elliott-Automation Limited, 34 Portland Place, London W1. Telephone: LANgham 9271.

Exhibitions and Conferences

Arranged in chronological order

Sports Goods Fair, International.—Sat., 1 July, to Mon., 3 July, 1961, at Weisbaden. Organised by the Verband Deutscher Sportgeschafte e.v., 182A Markstrasse, Krefeld-Rheinland.

Malta Trade Fair, Fifth.—Sat., 1 July, to Sat., 15 July, in Valletta. Organised by the Malta Fair Corporation, Exchange Buildings, Valletta, Malta.

Royal Agricultural Society's Show.—Tues., 4 July, to Fri., 7 July, 1961, in Cambridge. Organised by the Royal Agricultural Society of England, 35 Belgrave Square, London, SW1. Tel. BELgravia 5323.

Ophthalmic Optical Trade Exhibition and Conference.—Tues., 4 July, to Fri., 7 July, 1961, at the Royal Albert Hall, London, SW7. Organised by Ophthalmic Exhibitions Ltd., Columbia House, 69 Aldwych, London, WC2. Tel. CHAncery 6146.

Textiles Exhibition, International (INTERSTOFF).—Tues., 4 July, to Sat., 8 July, 1961, in Frankfurt. Agents in the United Kingdom: Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

Radio Techniques and Space Research, Convention.—Wed., 5 July, to Sun., 9 July, 1961, at Christ Church, Oxford. Organised by the British Institution of Radio Engineers, 9 Bedford Square, London, WC1. Tel. MUSeum 1901.

Russian Trade Fair.—Fri., 7 July, to Sat., 29 July, 1961, at Earl's Court, London, SW5. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Housewares Exhibit, National.—Mon., 10 July, to Fri., 14 July, 1961, at McCormick Place, Chicago. Organised by the National Housewares Manufacturers' Association, 1130 Merchandise Mart, Chicago 54, Illinois, USA.

Optical Instruments and Techniques, Conference.—Mon., 10 July, to Fri., 14 July, 1961, in London. Arranged, under the auspices of the International Commission for Optics, by the British National Committee for Physics. Inquiries should be sent to Mr. K. J. Habell, National Physical Laboratory, Teddington, Middlesex.

Great Yorkshire Agricultural Show.—Tues., 11 July, to Thurs., 13 July, 1961, at the Showground, Harrogate. Offices: Great Yorkshire Showyard, Hookstone Drive, Harrogate.

Inorganic Polymers, International Symposium on.—Tues., 18 July, to Fri., 21 July, 1961, at Nottingham University. Sponsored by the Chemical Society, Burlington House, Piccadilly, London, W1. Tel. REGent 0675.

Sydney International Trade Fair.—Tues., 1 Aug., to Sat., 12 Aug., at the Royal Agricultural Society's showground, Sydney, Australia. British participation is being organized by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London WC2. Tel. TEMple Bar 3422.

Pure and Applied Chemistry, 21st International Conference of the International Union of.—Wed., 2 Aug., to Sat., 5 Aug., in Montreal. Apply to the secretary-general of the International Union of Pure and Applied Chemistry, Dr. R. Morf, c/o F. Hoffman-La Rouche & Co., Basle 2, Switzerland. (*To be followed by 18th International Congress 6-12 Aug.*)

Pure and Applied Chemistry, 18th International Congress.—Sun., 6 Aug., to Sat., 12 Aug., in Montreal. Apply to the secretary, Central Committee, 18th International Congress of Pure and Applied Chemistry, National Research Council, Ottawa, Canada. (*To be preceded by 21st International Conference 2-5 Aug.*)

Dublin Horse Show.—Tues., 8 Aug., to Sat., 12 Aug., at Dublin. Organized by the Royal Dublin Society, Ball's Bridge, Dublin.

Canadian National Exhibition.—Fri., 18 Aug., to Mon., 4 Sept., in the Exhibition Grounds, Toronto. In the United Kingdom, apply to the Canadian National Exhibition Representative, British Columbia House, 3 Lower Regent Street, London SW1. Tel. WHItehall 2794.

Wellington International Trade Fair.—Tues., 22 Aug., to Sat., 9 Sept., in Wellington. Organized by the Wellington Show Association, Wellington, New Zealand.

International Civil Aviation Organization (ICAO): Diplomatic Conference on the Unification of Certain Rules Relating to International Carriage by Air Performed by a Person Other than the Contracting Carrier.—Tues., 29 Aug., in Montreal (tentative). Offices of ICAO: Montreal, Canada.

International Civil Aviation Organization (ICAO): North Atlantic Regional Air Navigation Meeting (Fourth).—Tues., 19 Sept., in Montreal (tentative). Offices of ICAO: Montreal, Canada.

Canadian Institute of Radio Engineers, Fifth Convention and Exposition.—Wed., 4 Oct., to Fri., 6 Oct., at Exhibition Park, Toronto. Offices of the Institute: 1819 Yonge Street, Toronto 7, Ontario, Canada.

Montreal International Trade Fair.—Thurs., 5 Oct., to Sat., 14 Oct., in Montreal. Apply to the Organizer, Montreal International Trade Fair, 227-228 Show Mart Building, Montreal, Canada.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., 4 Dec., to Fri., 8 Dec., at Earls Court, London, SW5. Organised by the Smithfield Show Joint Committee, c/o Society of Motor Manufacturers and Traders, Forbes House, Halkin Street, London, SW1. Tel. BELgravia 6611.

Motor Exhibition, International.—Fri., 2 Mar., to Sun., 11 Mar., 1962, in Copenhagen. Organised by the Danish Association of Automobile Manufacturers and Importers, 22 Amaliegade, Copenhagen K, Denmark.

Mechanical Handling Exhibition.—Tues., 8 May, to Fri., 18 May, 1962, at Earl's Court, London, SW5. Organised by the Iliffe journal *Mechanical Handling*, Dorset House, Stamford Street, London, SE1. Tel. WATerloo 3333.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

Chemical Society

LONDON
Reception and Conversazione. Science Museum, South Kensington, SW7. Thurs., 8 June, 6.30 p.m.

Institute of Physics and the Physical Society

LONDON
"Biophysical Applications of Non-Linear Acoustics," by Dr. W. L. Nyborg. Preceded by the Group's Annual General Meeting. Acoustics Group. Physics Department, Imperial College of Science and Technology, Prince Consort Road, South Kensington, SW7. Thurs., 8 June, 5.30 p.m.

Women's Engineering Society

LONDON
Annual General Meeting. London Branch. Hope House, 45 Great Peter Street, Westminster, SW1. Wed., 14 June, 7 p.m.

Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

Human Element

Mass Participation in Technical Training Week

THE gap between the speeches applauding technical training of the young and the performance in practice achieved in the United Kingdom is very wide. It is to be hoped that the Commonwealth Technical Training Week (29 May to 4 June) will bring the two closer together.

Last year some 72 per cent of young people who began work did so in jobs where there was no training, or only very little, and that of the turn-this-handle variety. In the nature of things the majority of firms taking part in the Week, and there are officially said to be almost 56,000 of them, are organizations who already support the ideals of adequate technical training for the young, not only for its own sake but for the future of a sufficient skilled population in Britain. Yet 56,000 firms is so considerable a slice of the economic structure of the country that there must be some firms taking part if not with tongue in cheek, then at least with a need to go back after the speeches and the congratulations and do something about increasing the miserably small proportion of the country's youth who are trained to be skilled workers.

Local authority participation in Scotland, Northern Ireland and Wales is 100 per cent. In England only three county boroughs and one county council are not taking part. The Duke of Edinburgh, who suggested the training week after seeing the work of an apprentice in Melbourne, is putting a busier week into the event than most. Using aircraft and helicopters on a scale not yet reached by many business leaders, he will be attending ceremonies and services in Belfast, Glasgow, Edinburgh, Birmingham, Cardiff and St. Paul's Cathedral in London.

Italy to Grow by Expanding Demand

Although Italy's economic expansion last year was as fast as almost any in Europe, the planned rate of reduction in the large number of unemployed was not maintained.

This is pointed out in an OEEC report on Italy published earlier this month which says that the impressive rate of growth reached by the Italians was made attainable by the early restoration and maintenance of a stable financial position; by a high and more or less uninterrupted rate of investment; by fairly modest wage increases; and by the part absorption of the pool of unemployed. All of this, with the added effects of improved productivity, has made Italian exports very competitive. Large markets, giving the exporters the chance to flex their commercial muscles, have been materially helped by liberal trade and payments policies. The OEEC have put forward three proposals for a better handling of the unemployment problem in Italy.

The serious problems of the South, where much of the poverty is concentrated, should be tackled by a major effort to create new industrial centres in that region.

As in other member countries of the OEEC, agriculture is not keeping up with the advance of industry. In Italy some 30 per cent of the population are concerned with agriculture whose value is under 20 per cent of the national product. Selected schemes of intensive cultivation, again bearing the South in mind, are proposed by OEEC.

While maintaining financial stability, the greatest attainable expansion is advocated, since the latest levels of growth suggest that in the next few years even greater rates of advance are possible than those reached in the late 1950's. Italy has a balance of payments surplus which is taken by the OEEC as an illustration of the margin on which a more rapid expansion of the domestic market could be based, thus sustaining the growth of capacity and of productivity.

The Customer is always Served

Automatic vending machines able to provide a selection of goods the housewife may need—including eggs—are very big brothers indeed to the cigarette and chocolate machines, still the most commonly met automatic selling equipment.

The Automatic Vending Exhibition in the New Horticultural Hall showed one such machine, among a number of advanced "mechanical salesmen." At £2,500 a time, it is reasonable to expect that the advantage such a round-the-clock device will give to its ambitious owner could cause a rapid increase in the number of such machines in operation.

There are two disadvantages to the supermarket, one of which it shares with most other shops. Both of them provide the opportunity for the automatic vending machine of versatility. Housewives who have popped into the supermarket on the way home from the hairdresser are not happy waiting behind a queue of several heavily laden shoppers for their turn to pay for a tin of peas. The other factor in the equation is the time-honoured one of the busy mother who finds at the last moment that she is out of bacon, or cooking fat or even bread. For both these situations the big automatic machine can provide the remedy.

The prospect opened up by these machines is nothing less than a major change in general shopping habits. If it is no longer necessary to make agonised last minute appeals to the neighbours, or to smile bravely while fuming in a queue, this may be a loss of social contact but it may also make for a calmer life. The effects can hardly be expected to be confined to shopping for food. If eggs and electric lamps can be sold by machine why not petrol or airline tickets. British Railways could cut their staff overheads and earn a handsome bonus in goodwill if by introducing the automatic vending principle to the sale of tickets the booking office queues could be turned into memories.

Mr. Robens, the National Coal Board chairman, who is proving as lively on the subject of coal as Mr. Marples on roads, demonstrated how 28 lb of coal could be obtained for 4*s* from a machine. The storage capacity of such machines seems likely to limit the contribution they could make to spreading out the seasonal nature of demand on the coal merchants.

Prolonged Preparations for Commonwealth Week

Major-General C. Lloyd, chief officer of the central advisory committee for the Commonwealth Technical Training Week, has said that the organization culminating in the coming week's events began two years ago. Part of the build up, back in February, was a BBC television broadcast, in which, as part of a survey of the significance of the Week for Wales, three South Wales Switchgear apprentices appeared and demonstrated a lathe, control panel and a circuit breaker. The importance of the work the company is doing in technical training was underlined by the point, made by the apprentices, that in the home areas of all three there were no facilities for technical education.

The technical training activities of South Wales Switchgear, in addition to creating the skilled men needed by the company, serves also the social objective of keeping young people in Wales and helps in increasing the number of trained young workers without whom new industries would be unable or unwilling to move into Wales.

Staying Alive in the Factory

Later this year and for some time ahead increasing numbers of young people will be leaving school for industry and if care is not taken a proportionate rise in accidents will follow. The annual report of the Chief Inspector of Factories for 1959 pointed to the rise then taking place in young people's accidents in industry. The answer seems to lie at least in part in greater attention to emphasis on safety in schools and technical colleges and on early training in factories and on construction sites.

The quarterly *Accidents—How they Happen*, published by HM Stationery Office (1*s* 3*d*) for the Ministry of Labour, describes in detail thirty accidents, from the loss of four fingers in a paper making machine to the fall of a plate from its grab, with fatal results, and fires and explosions of magnesium. Seven of the thirty accidents were to young people. For those responsible for young people coming into employment there is an extremely useful Ministry of Labour leaflet, *The Prevention of Accidents to Young Workers* (Factory Form 281, Stationery Office, 6*d*) which is informative on selection, instruction training and supervision.

The mishaps and tragedies described vary from failures of common sense to breakdowns in necessary teamwork.

Stacking circular saw blades on edge in a pile leaning against the wall is dangerous as well as bad for the blades. Proper racks should be provided and used. In a recent sawmill accident blades of diameters up to 4 ft were stacked on edge leaning up against a wall. When a saw doctor wanted to return a blade to somewhere near the middle of the pile he pulled forward a number of blades, resting them against his leg. He lost his balance and the weight against his leg pushed him over. He suffered a fractured leg and his other injuries included head cuts from the backward fall.

A more serious accident, leading to death on the top of a blast furnace, might have been avoided by better communication between the members of a team. The bell on the top of the furnace had jammed open and smoke and fumes were pouring out.

If, as seemed to be the case, a bell crank lever jammed, the result was tilting of the bell. The established practice was for the bell to be restored to its normal position using two chains and a pull lift. A maintenance foreman and six others, going to the top to do the job, spread out as in the usual drill, one man staying with the chains and pull lift near one of the counterweights.

This man was obscured by the smoke but it appeared that he assumed he would have to attach a chain to the counterweight as on previous occasions. Meanwhile the others found that the ramming gear had become derailed and simply put it right, using levers. The effect was that the bucket truck was moved back, the bell closed normally and the counterweight dropped back into its normal closed position.

The tragedy occurred because as it did so the man placing the chain had his head in an 11 in gap between it and a hole in the platform through which the weight dropped. Death was thought to be instantaneous.

The points emphasised are the need for strict control of men working in parties; adequate and well understood signalling systems; one man only to signal and then only when he knows his signal will not cause danger; the man nominally in charge to take charge in fact so that clear instructions are given and understood before any action is begun.

Accident Statistics

TABLE: The numbers of people killed and injured as a result of accidents notified to HM Inspectors of Factories in the quarter ended 31 December, 1960

Process	Persons fatally injured	Persons injured (but not fatally)	Total
Textiles and connected processes	1	3,087	3,088
Clay, Minerals, etc.	6	1,451	1,457
Metal processes	22	6,905	6,927
General engineering	21	13,850	13,871
Electrical engineering	1	1,884	1,885
Wood and cork working processes	6	1,996	2,002
Chemical industries	12	2,465	2,477
Wearing apparel	—	576	576
Paper and printing trades	2	2,028	2,030
Food and allied trades	2	4,233	4,235
Miscellaneous	7	3,281	3,288
TOTAL	80	41,756	41,836
Processes under Sections 105, 107 and 108 of the Factories Act, 1937	51	4,514	4,565
Building Operations	16	1,097	1,113
Works of engineering construction	14	2,055	2,069
Works at docks, wharves and quays / Work at inland warehouses			
GRAND TOTAL	161	49,422	49,583

Commonwealth Cooperation in Education

Rising standards of living in the Commonwealth depend as much on giving technical education to millions more of its citizens as on any other factor. The shortage of teachers is so great that it endangers the training of sufficient staff for the necessary expansion.

THE common link relating the 3,000 technical students of the Salisbury Polytechnic, in Southern Rhodesia, the hard working Australians and New Zealanders taking their official correspondence courses, and the Indian and other students training in great engineering works around the United Kingdom is the urgent need shared by every Commonwealth country for more graduate engineers, more technicians and more workers equipped with the essential skills of manufacturing industry.

The three main streams in Commonwealth technical education are totally different from each other though related. Great Britain, Australia, New Zealand and Canada are nations substantially developed, although still growing and changing at a speed that makes heavy educational demands. Their educational systems are in the, largely state, schools and go on through successive stages to technical and university courses, massively supplemented by the apprentice training and specialist engineer courses of established industry.

Quite different problems are encountered in the emerging, newly independent territories. A great dearth of professional engineers, which can be eased by recruitment from abroad and by the use of consultants, is made more difficult by a sometimes total absence of local labour able to tackle any job higher than the simplest artisan functions. For these states, with few great industries providing training facilities, the whole responsibility for education, from the reading and writing level up to graduate courses, falls squarely upon the authorities, aided to some extent by funds from Britain, and in various degree of association with the British universities.

The third stream is that of Commonwealth engineering students coming to Britain (and also to West Germany and the United States) for training in industry. This is a two way business, the student gains more advanced engineering knowledge and returns to his country better able to assist in the industrial development of his country. Due to the thinness on the ground of qualified engineers such graduates of industry often rise swiftly to important executive positions.

Not all training of Commonwealth technical students outside their own countries is carried on in Britain; Australia has its share of Colombo Plan Asian students and this is only one example.

Among the nations most newly feeling the joys and cares of independence are the Nigerians. Their country promises to move ahead as fast as any in West Africa and has some of the problems of starting from rather basic situations.

TECHNICAL EDUCATION IN NIGERIA

Nigeria has made considerable progress during the last 10 years in the field of technical training at all levels, but today the challenge of economic growth demands that more effort be put into this important task of developing vocational and technical training. The economic climate for industrial development has become more favourable, and with the advent of independence Nigeria looks forward to an increase in technical educational facilities to meet economic growth.

The facilities for technical education which exist at present in the Federation are many and varied; the high level training is done at the Nigerian College of Technology while the sub-professional and craft training is done in the technical institutes and trade centres in Lagos and the regions.

The main purpose of the college is to provide academic courses which will lead to professional qualifications. It is a Federal institution with three branches complementary to one another forming a single unit. Its Department of Engineering at Zaria is now a Faculty of Engineering of the University College, Ibadan, and courses are provided in civil, mechanical and electrical engineering for the degree of the University of London, under a scheme of special relationship.

The Enugu branch provides courses in land surveying and estate management, while the Ibadan branch concentrates on commercial courses leading to professional examination in accountancy and secretarial work.

In addition to these technical and commercial courses there is a large department of pharmacy where students train to become pharmacists and gain their diploma of the Pharmacy Board of Nigeria. Teachers are also trained in the Department of Education, while the department of Fine Art offers diploma courses in fine art and commercial design.

The College was established in 1951 and has made considerable progress; it is hoped that as a result of the Ashby Commission's report it will be integrated into the University system of Nigeria thus playing an important role in the university education of the future.

SUB-PROFESSIONAL TRAINING

There are three Government Technical Institutes, one at Yaba, near Lagos, one at Enugu in the Eastern Region, and one at Kaduna in the Northern Region, while a Technical College has just been completed at Ibadan in the Western Region. These technical institutions provide a variety of full-time, sandwich, part-time and evening courses, ranging from the junior technical school level to the standard of the Ordinary National Certificate of the United Kingdom. The approximate total number of students in all these institutions is about 2,500. Commercial course are also provided which lead to the certificates in commercial subjects of the Royal Society of Arts. There are also two Federal Training Centres operated by the Federal Ministry of Establishments, one at Lagos and the other at Kaduna.

Major expansion in technical training is expected in the near future. This has been made possible at the Yaba Technical Institute by the gift of £500,000 by the Shell-BP Company. The recent report of the Ashby Commission envisages changes and expansion to meet the growing needs of Nigeria in this field. Thus technical subjects below university level will be taught at the Yaba Technical Institute and in the Regions. It is hoped also to introduce the Higher Certificate of the City and Guilds of the London Institute at the Yaba Technical Institute thus enabling promising students to reach a higher academic attainment and be fitted for the more important technician posts in civil, mechanical and electrical engineering. It is intended to expand as soon as possible the commercial courses at Yaba and provide group courses in commercial subjects leading to the Royal Society of Arts Certificates.

The great problem which faces the expansion of technical education is the lack of qualified staff to teach technical subjects and this shortage is apparent at all levels. Through the help of international agencies such as UNESCO and International Labour Organization and technical assistance from Commonwealth and other countries, it is hoped that suitable staff can be found to meet the needs of Nigeria until trained personnel of its own can be produced.

The supervision and management training courses which were started in the middle of 1959 by the Federal Ministry of Education are now firmly established and are making an important contribution to the development of Nigerian managers. These courses are being organized and run by PE Management Group (Nigeria) Limited, and a member of a British group of management consultants for the Federal Ministry.

By the end of this financial year 27 courses attended by a total of 450 students will have been held. The demand for places on the courses during 1960 has been considerably higher than could be met and therefore arrangements have been made to expand the courses to accommodate 600 day students in the next financial year 1961-62.

The report made by the Federation of British Industries' reconnaissance team earlier this year said that trade schools were good but that there was not enough provision for technician training. Provision of teachers and teacher training appeared to be the worst bottleneck. The United Kingdom could perhaps contribute the most useful aid.

Science and engineering faculties seem to suffer a lack of teaching aids about industry, and an inability to give practical experience to graduates. This is one of the central dilemmas of any under-developed state. Experienced graduates are needed to build up local industry. Until there is local industry it is not easy to give graduates experience.

The FBI has undertaken to see that wall charts, models and films on industry are supplied and also to give five immediate FBI scholarships. These will be held in British factories and laboratories and are reserved for Nigerians who have graduated in Nigerian educational establishments. Before this departure, FBI scholarships had been held only by those Nigerians with academic training in Britain.

RHODESIAS AND NYASALAND

The development of industry and commerce in the Federation is comparatively recent, in general since the Second World War, and as the country has relied mainly on recruiting its skilled man-power from overseas, facilities for technical education are only just beginning to be provided on an adequate scale. Developments are now taking place at a fairly rapid pace.

All four Governments, the Federal and the three Territorial Governments, share responsibility for education and training. The Federal responsibility is for technical education for Europeans, Asians and Coloureds and also for advanced technological training for all races,

New Zealand's economy and sheep are inseparable: a wool classing course in progress at Canterbury Agricultural College.

while the Territorial Governments are responsible for African education and also for training in industry.

The present provision by the Federal Government consists of two Technical High Schools in Southern Rhodesia with an engineering bias, two technical colleges in Salisbury and Bulawayo, and a small technical institute in each of the main outlying centres of the Federation. The Salisbury Polytechnic is the largest with an enrolment of 3,000 students engaged in studying at the craft, technician, and technologist level. This College is about to be provided with a new building at a cost of £400,000. Large extensions are also taking place in Bulawayo, the second largest college in the Federation.

The Federal Government aids the Copperbelt Technical Foundation which was set up by the mining companies a few years ago and which controls four colleges in the Copperbelt. Kitwe, the largest of these four colleges, has already begun advanced work and is likely to become the main centre of the Copperbelt. Another institute has recently been provided in the Copperbelt by the inhabitants and this also is grant-aided. Plans are in preparation for the building of a new commercial college in Northern Rhodesia, while in Southern Rhodesia there is a college for advanced training in agriculture for Europeans, and another for Africans at a similar level is due to be opened shortly. There is also a University College in Salisbury which is multi-racial and is aided by the Federal Government.

The Southern Rhodesia Government has recently provided two technical high schools for Africans—one for engineering and the other for building. It has also provided a technical teacher training college for training African craft instructors and this college is being extended for the purpose of providing technical education for African apprentices. There are fourteen industrial schools which provide courses mainly in agriculture and rural building.

The Northern Rhodesia Government has provided a college for training African craftsmen and instructors in engineering and building. There are also some fifteen trade schools for building craftsmen which are either maintained or are aided (mission schools). An adult education centre is about to be provided for technical and commercial education.

In Nyasaland facilities for technical education are limited to one small institute which is carried on on a part-time basis.

COMPULSORY DAY RELEASE

Training in industry has followed British traditions of apprenticeship for craftsmen and technicians, the higher ranks being filled by university men trained overseas.

Apprenticeship is controlled by the Territorial Governments and day or block release for technical education is compulsory in Southern and Northern Rhodesia. The training of Africans until recently has been restricted in the main to semiskilled work and craft occupations in agriculture and rural building, although in Northern Rhodesia the product of the trade schools is used on "fragmented" craft work in industry under the control of Europeans.

In Nyasaland, Africans are engaged in varied forms of craft work and are trained on the job through a system of apprenticeship.

Recently a non-racial Apprenticeship Act has been passed in Southern Rhodesia which is opening the doors of apprenticeship to Europeans and Africans alike on equal terms. A similar Ordinance is in force in Northern Rhodesia although so far only one African has been admitted into apprenticeship.

The Apprenticeship Committees which have been set up under the Southern Rhodesia Apprenticeship Act have already agreed to recognise various forms of apprenticeship so as to overcome the difficulties created by the widespread nature of industry and racial differences of tradition. Thus, there will be: (i) The existing on-the-job training together with day release for technical education. (ii) On-the-job training and full-time block release for technical education, and (iii) trade school education and training for two or three years followed by on-the-job training in industry.

There will also be separate schemes for training craftsmen and technicians, and students will follow City and Guilds courses as is done in the United Kingdom.

Arrangements are now being made in Southern Rhodesia to meet these varied forms of education and training, both by the Federal and Territorial Governments. It is expected, however, that many employers will prefer the trade school method for Africans for the first few years of apprenticeship rather than on-the-job training. This will enable the Africans to acquire in a systematic way British traditions of craftsmanship before completing their training on-the-job. There is evidence that a number of Europeans will also prefer this method of apprenticeship.

The leading companies in the Federation such as the railways, the copper mining companies, Unilevers and African Explosives (I.C.I.), have very highly organized training schemes and work in close cooperation with the technical colleges. Training schemes include training at levels from management to the semi-skilled worker.

Many Indian students have trained at the Sheffield works of Davy and United. One of them here assists in building equipment for the Durgapur Steelworks in West Bengal.

PLANS FOR GHANA

The educational and training facilities of Ghana need to be seen against the broad economic background of the country. Most of its people make a living from agriculture, forestry, mining and fishing. Cocoa production employs 750,000 or a sixth of the whole 6·7 million population. At the end of 1959 there were 320,000 people working in industry.

Free basic primary education is state provided and the Government aims eventually to make primary and middle school education free and compulsory. Mass literacy campaigns are planned and the expansion of technical and scientific education.

Ghana's University College provides courses for University of London external degrees in arts and science. Kumasi College of Technology concentrates on engineering and technological education. The College's engineering degree course is recognized by the University of London.

During 1959-1960 there were 354 Ghanaians attending university courses in the United Kingdom.

An outline of Ghana's progress in the numbers receiving education is given in the table.

State Education 1950 and 1959

	1950		1959	
	No. of pupils enrolled	No. of teachers	No. of pupils enrolled	No. of teachers
Primary and Middle Education	204,262	8,840	605,274	19,404
Secondary Schools	2,216	450	10,499	650
Technical Institutes	945	—	4,563	79
Teaching Training Colleges ..	1,776	220	4,274	348
Kumasi College of Technology (opened 1952)	—	—	615	81
University College of Ghana ..	108	70	519	143

For Australia, whose industry is in many respects as advanced as any in the world, technical education is as closely involved between universities, technical institutions and company facilities as in the United Kingdom or Canada. Both New Zealand and Australia have well developed technical correspondence school systems.

New Zealand, whose population tends to be gathered in small, far-apart pockets, has the Technical Correspondence School, with 92 full time teachers, catering for one in five of the apprentices in the country. Courses range from radio and television to horticulture and farming, with others on industrial and business management. In some special fields the school provides the only tuition given by the State system.

This is a small part of the educational effort of Australia and New Zealand but a highly developed answer to a special case, worth mentioning apart from the high standards reached in other, more usual aspects of technical education.

For a country to whom agriculture is an important as it is for New Zealand a significant part of its technical education must lie in that direction. The Canterbury Agricultural College in the South Island is an important part of the educational provision.

Deeply involved with her own schemes for widening the scope and reach of technical education, India is also the scene of some notable cooperation with British industry. Elsewhere in the Commonwealth devoted attention is being given by university staffs and by industrialists to creating the trained engineers and technicians on whose skill manufacturing economies depend.

Cars Designed to Feel at Home Anywhere

To capture Commonwealth markets, the motor car designer must produce a basic model that, with only minor alterations, is suited to conditions from the equator to the poles.

By John Rabson, A.M.I.Mech.E., M.S.A.E.

IN A number of countries, the advance of civilization is marked first by the importation of cars, and later by a desire on the part of the country concerned to have its own manufacturing industry. This pattern of events must affect not only that country, but also those countries which have a more established business with vehicle production, and do in fact rely on it to form part of their export economy. There will undoubtedly always be potential export business for those countries producing vehicles which are different from the ones made in the areas to which they are exported, but nevertheless there is a growing tendency, in some countries at least, towards supporting local industry at the expense of imports.

COMPLETELY KNOCKED DOWN

The British motor manufacturer is not alone in his realization of this state of affairs, and assembly plants closely related to Coventry and Detroit are found in Commonwealth countries as well as in Asia and Europe. In general, the trend has been first to export vehicles as finished cars, later to ship them in the "completely knocked down" condition (CKD), to be built up by local labour, and then at a later stage to increase the number of locally made parts and reduce the content of the vehicle that is supplied by the base factory.

This process is logical, in that it satisfies the ever increasing demand for personal transport in a much shorter time than would be possible if a completely new vehicle were designed and developed and then mass-produced with only limited resources—but at the same time it does presuppose that a basic design is satisfactory for world markets.

By contrast, at one time the British motor industry was chiefly concerned with supplying transport to operate within the small range in latitude from Land's End to John O'Groats. All this has now changed, and there is relatively little difference between the home market model and the export version which may find its way into service on the other side of the world. The need for export has made it necessary to improve the overall standard of the vehicle, and the result of this work means that not only is it possible to use one basic design for world markets, but also the home market customer probably gets a much more robust vehicle.

UNIVERSAL STANDARD

Today the vehicle designer must survey wide horizons, and evolve a car that is insensitive to detail variations that can occur in the supply of the component parts from which it is produced. Because of the large amount of capital expenditure involved, it is not possible to consider designing a separate car specially for each section of the world market, and in fact there is little point in trying to do so, because if the basic design is sound, the variations required to suit differences in operating conditions can frequently be produced by relatively small specification changes. These modifications can be incorporated at the main factory if vehicles are exported in the finished condition, or they may be part of the gradually increasing percentage of local content that is encouraged in Commonwealth countries, for example, where vehicle assembly or perhaps partial manufacture may take place.

There are two distinct ways in which a vehicle can be modified to suit local conditions. It may be done by altering the detail appearance (changes to either internal or external trim), or it can be by means of modification to one or other of the mechanical components. Both items are equally important, because at a time when there is a tendency to take for granted the mechanical components that are vital but unseen, it must not be forgotten that cars are frequently sold by the impact that their appearance makes on the prospective customer.

LOCAL CONTENT

An analysis of the local content included in British cars assembled in the Commonwealth indicates that there is a variety of items or components that show the way in which these countries are starting to lay the foundations of their own industry, without needing to build complete vehicle manufacturing plants—although in a few cases these exist or are planned for the future. The rate at which progress takes place depends, of course, on many factors, and varies from country to country. The following examples show the general state of the industry, although only a few different makes are mentioned here.

First, there are the assembly plants. The Ford Motor Company assembles vehicles in Australia, Malaya, Pakistan and Hong Kong, the majority of the vehicles being built up from parts imported by those countries, although there is a certain local content, and not unnaturally the largest percentage is included in those cars assembled in Australia. This trend is endorsed by Standard-Triumph, with assembly plants in Australia, New Zealand and India.

The Holden car, built largely by Australians for Australian demand, is equally adapted for other markets. The 1960-61 station sedan is one of several versions now available.

The locally made content of that company's vehicles marketed in Australia is around 50 per cent, and includes glass, tyres, batteries, springs, pistons, sparking plugs, transmission components, radiators, seats and trim. In India, the average local content is even higher than the figure for Australia, as apart from most of the previously mentioned items, engines, brakes and clutches are also made locally.

Of all the Commonwealth countries, perhaps Australia is farthest in the lead as regards establishing its own complete motor industry, and here some of the credit must be given to General Motors-Holden's. Backed by the resources of the General Motors organization, over 90 per cent of these vehicles are manufactured in Australia by Holden's themselves, supported by a number of component manufacturers. In the period between 1947 and 1959 the output of Holden cars steadily increased year by year from 10,000 to over 100,000.

From the analysis of the present manufacturing, certain patterns emerge. There is a tendency first to concentrate on the manufacture of components, particularly those items which it is reasonable to suppose will require replacement several times during the useful life of the vehicle. Tyres, batteries and sparking plugs are of course obvious examples.

Taking the examination a stage further, encouragement of the growth of vehicle component manufacturing industries is the correct approach on the part of the countries concerned. Because of the ability to use these items on more than one model or make of vehicle, the production quantities are likely to be sufficiently large to warrant the installation of expensive machinery, even if the total output of one particular make or model is relatively small.

Further, it is frequently found that it is the component rather than the complete vehicle which may need modification if it is desired to tailor a vehicle more accurately to local conditions. For example, in cold countries, obviously special attention is required to ensure that the heating and de-icing equipment is adequate, and again, because of the more difficult conditions associated with cold operation, a different thermostate setting and perhaps a larger battery would be desirable.

REGIONAL VARIATIONS

If the car is to operate in hot climates, the emphasis might be on improving cooling, which might require a larger radiator, or a greater number of blades on the fan, or even, in the case of more expensive models, a complete air-conditioning and refrigeration plant.

In very dusty conditions, extra emphasis would be placed on sealing and filtration, with perhaps an oil-bath filter in addition to the normal intake silencer, to give greater protection against the intake of foreign particles to the engine via the carburettor. If the road surfaces are bad, perhaps larger section tyres together with some modification to the road springs and shock absorber settings, would be indicated. All of these items are generally bought-out components as far as a British manufacturer is concerned, and therefore it is a much more straightforward proposition to tailor the car to suit an individual market by changing items of this sort, rather than by introducing basic changes which would prevent the vehicle design from being acceptable throughout the world.

Although differences in climate and operating conditions exist, and it has been indicated how steps are taken to meet local needs, it must also be remembered that before a new model can be released for production with confidence, it must be fully developed and tested. Here again the motor industry has done much to ensure that its products are suitable for the wide variety of conditions that are met, assisted in this country by the facilities available at the Motor Industry Research Association's proving ground at Lindley, where a vehicle can be thoroughly tested to see how it will perform on typical sections of the varied terrain over which its production counterpart will be driven in later life.

It was mentioned earlier that cars are frequently sold on their appearance, and it is particularly important to make certain the customer gets what he wants. In some countries local conditions and public taste may dicatate bright colours and perhaps extra bright trim parts, and these modifications can usually be done with little or no change to the basic design of the vehicle, yet they make it more attractive for a particular market. There are more important aspects of interior trim and fittings that must not be overlooked. Perhaps the most important is the average dimensions of the people living in the country for which the particular car is intended, as even with the more generous seat adjustments which are now sometimes found, it might be difficult to accommodate both a pygmy and a giant on the same design of seat.

Commonwealth Investment

NUCLEAR power's foot-hold in the individual countries of the Commonwealth is dependent upon the amount of minerals or natural resources of power that the country has at its disposal. But even those countries which have adequate natural resources of their own have not failed to recognize the importance of atomic energy. All countries, no matter how wealthy in finance or natural resources, make use of radio-isotopes. The following survey shows that most countries, even if they have no nuclear programme, are at least conscious of the future part to be played by nuclear power. In order to obtain experience in the nuclear field, departments are being set up to train scientists in nuclear technology, so that there will be a trained nucleus from which the nuclear programme may expand in the future when an additional source of power is required.

Canada

Although Canada has large mineral and hydro-electric resources of her own, she has developed an extensive nuclear programme, and now has eight reactors either critical or under construction. Ontario is the one place that nuclear power could economically serve, since its industries are fed by electricity generated from coal imported at $8 per short ton. In the western provinces where there are vast resources of natural gas and untapped hydro-electric potential, it is unlikely that any existing type of reactor could compete economically until its technology is more advanced. In northern Canada, where the communities require stations producing about 40 MW(e), the situation is similar. The recent activity in uranium was reported in Atomic Review, 10 Feb. '61.

Early Start

The ZEEP reactor went into operation in September, 1945, and was the first reactor to operate outside the United States. The Canadians have concentrated largely on the heavy water type of reactor, and although this reactor system has several disadvantages, chiefly economical, they claim that these have been overcome. Initially the expense of the heavy water moderating and cooling material put this type of reactor system out of favour, but the experience gained from the NRX and the NRU reactors is claimed to have solved the problem of heavy water leakage. The Canadians have designed not for zero leakage with all the associated problems of totally sealed pumps, valves and joints, but for minimum leakage using normal equipment and collecting any leaks both liquid and vapour in a vapour-proof space. The final proof of this philosophy has still to be made in a fully operational plant, and significant results will be available from NPD later this year.

Changes to Initial NPD Design

Since the design of NPD several major changes have been made for its high powered successor, CANDU. In order to overcome the trials of using an overall pressure vessel specified for the NPD, pressure tubes have been substituted to contain the pressure system. This has removed one of the major problems to the design and manufacture of a large nuclear power station using heavy water as the moderator and natural uranium as the fuel. Bi-directional fueling was also introduced. After a considerable delay to the programme these improvements were incorporated in the final NPD design. Canada's faith that the system was sound is shown by the authorization for the construction of the full scale CANDU project before the prototype had been built. The CANDU project will have two separate reactors, but initially only one reactor is to be built and from experience gained with the first reactor any modifications that are considered necessary will be able to be incorporated in the second. The burn-up values are claimed to be at least 9,750 MWd per tonne.

Other Systems

A decision is expected to be made shortly whether the 40 MW reactor OCDRE should be built—this reactor uses organic coolant. Another reactor under consideration is one using heavy water for the moderator and uranium oxide fuel but the coolant is high pressure steam. The steam would be superheated in the reactor. The reactor would have a higher efficiency than the 33 per cent estimated for CANDU, and would be suitable for even larger sizes. There is also a 1 MW swimming pool research reactor at McMaster University, Ontario, made by American Machine and Foundry Limited.

India

India's need to find some other source of power is greater than any of the other Commonwealth countries, and her own reources of coal, oil and hydro-electricity will soon prove to be inadequate if some other source of power is not found. In many cases the transportation of the coal is critical since the fields are often a long way from the industrial centres (up to 1,000 miles). The hydro-electric sources are also unevenly distributed about the country. Although the conventional sources are being expanded as rapidly as possible, it has been felt necessary to make a substantial beginning with nuclear power so that a fully developed nuclear industry may be built up in the country as soon as possible. Two small low powered research reactors have been built to train scientists in nuclear technology and investigate various reactor systems. The Canada-India reactor has been given to India under the Colombo Plan and will be used for research and radio-isotope production. The construction of the reactor is similar to the NRX reactor at Chalk River. Canada was responsible for the design and construction of the reactor while India executed all the civil and auxiliary works. The site chosen for the first power station is at Tarapur, 62 miles from Bombay. The specification was released last October for a station having an electrical capacity of 300 MW to be produced by two reactors of equal size. The tenders are expected to be submitted by August and it is hoped that construction will begin early in 1962.

Material Processing

A special thorium plant was built in 1955 at Alwaye and Trombay to treat the monazite ore containing 9 per cent thorium Uranian production has been taking place since 1959 in Trombay where a uranium refinery purifies the crude uranium floride obtained as a by-product of the thorium plant. The uranium for the Canada-India and Zerlina reactors has been treated at the plant. The fuel elements for the Canada-India reactor have also been fabricated by the Atomic Energy Establishment. Heavy water is produced as a by-product of the Nangal Fertilizer Plant and when operation commences at the end of 1961, it is expected to produce 15 tonnes of heavy water annually.

Australia

The Australian Atomic Energy Commission was created in April, 1953. The country's immediate need for some other form of power is not great but an intensive research and development programme is under way. The present programme which was crystallised in 1955 started with two basic reactor projects. The liquid metal fuelled reactor and the high temperature gas cooled reactor with beryllium for the moderating material and thorium and uranium for the fuel. The liquid metal fuel reactor was abandoned, apart from small scale work.

Material Studies

The current programme is mainly concerned with the study of three types of fuel elements: uranium and thorium oxide dispersed in beryllium oxide, uranium and thorium metal in beryllium metal (as metallic compounds), and uranium and thorium carbide dispersed in graphite. The emphasis on beryllium is influenced by Australia's wealth of this material. The second part of the programme is concerned with coolant gases: carbon dioxide, helium, and nitrogen. Helium gives trouble due to the difficulty in obtaining gas tight joints. The faith that the Australians have for beryllium was affirmed recently by Professor J. P. Baxter, chairman of Atomic Energy Commission, who said that within the next four or five years a design for a high temperature gas cooled reactor should be brought forward using beryllium canning (Atomic Review, 7 April '61). There are two research reactors at Lucas Heights, and it will be some time before reactors are built for power production. Basically because there is no severe shortage of power in the country and high temperature system chosen requires much research and development before a power reactor of that type can be built. However the ultimate repayment of this type of system with the higher tempratures will result in a more efficient station. Australia has also been found to have an abundance of uranium.

Pakistan

It has recently been announced that plans are being established for three reactors in Pakistan. At the present time the Pakistan Atomic Energy Commission has no reactor, but over the next three years it is hoped that two training and research reactors will be available. One will be a swimming pool type reactor using low enrichment fuel to be built in west Pakistan, and the other a gas cooled graphite moderated reactor to be built in east Pakistan. The third reactor will have a high power rating and will be used for electricity production. Pakistan is very short of natural resources and the Commission is anxious to keep up-to-date with nuclear developments. A number of scientists will be sent abroad during the next five years for training. At the end of this period a nuclear reactor institute should be under construction at Islamabad and by June next year two research laboratories will have been set up, at Lahore and Dacca.

South Africa

Atomic energy in South Africa has not got a strong foot-hold since there is no urgent need to find some other form of power producer because natural resources are adequate, and until the present time the only use of atomic energy has been for radio-isotopes. South Africa's main interest is in uranium, since uranium oxide is derived as a by-product of gold. (Atomic Review, 10 Feb. '61, and 14 April '61.)

New Zealand

Although hydro-electric sources in New Zealand are numerous and many remain untapped, New Zealand has formed an Institute of Nuclear Sciences. Laboratories and facilities are being established. It is hoped that a 1 MW swimming pool reactor with shielding and cooling provisions for an ultimate power of 5 MW will be installed.

Ghana

The National Research Council of Ghana is responsible for atomic energy and a health physics and radio-isotope unit have been set up. The country's lack of fuel and high importation costs, and also the rapid growth of national electricity demand make it necessary to seek further power supplies. Although the possibility of building a reactor has been considered, the need is not so urgent now that the Volta Project is progressing.

CLINOMETER

Reads Direct to 1 Minute

DIRECT readings to 1 minute of angle can be obtained on the 360° clinometer illustrated.

The instrument has a circular scale totally enclosed in the dust tight body. It has a ground steel base. An adjustable base can be supplied as an extra item for use on surfaces that are not truly horizontal.

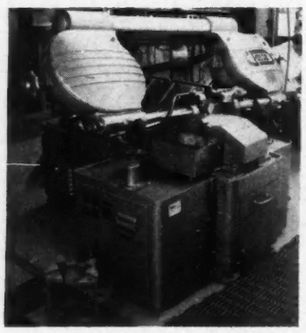
The circular scale is divided 0-180-0 at one degree intervals and figured every 10°. It is read through a glass covered aperture in the front. The scale is subdivided by an external micrometer, the drum of which is graduated in minutes and figured every 5 minutes. Estimation to 30 sec is easily achieved.

The spirit level rotates with the scale and is incorporated in a quick setting control knob, the top edge of which is cut away to give a clear view of the bubble. The datum of the circular scale is indicated by the spirit level and the scale is rotated by a micrometer, through a worm drive. The drive can be disengaged by depressing the micrometer drum; coarse setting is then made by rotating the spirit level by hand. The worm spindle is spring loaded to avoid backlash.

The instrument measures 5⅜ in overall height by 5 in length. The width of the base is 1½ in. Accuracy is to within 1½ minutes and the weight is 2¾ lb. It is supplied complete in a wooden travelling case. *Hilger and Watts Limited, 98 St. Pancras Way, Camden Road, London NW1.*

HORIZONTAL BANDSAW

For Repetition Work



PRECISE repetition cutting can be carried out with the Fortemat BA251 horizontal bandsaw.

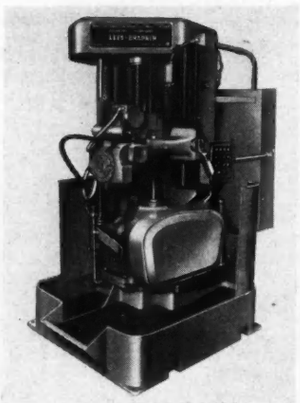
The machine has a hydraulic feed for the stock using two vices. After a cut the first vice releases the bar and the second slides it forward the set amount; the first then grips and the second releases and withdraws ready for the next feed movement. The feed is controlled by an adjustable stop, repetition being to close tolerances. The feed can be varied from zero up to 16 in using a single stroke; with a double stroke the maximum is 32 in.

The machine has a capacity for round or square bar up to 10 in diameter or equivalent. The cutting speed of the saw is steplessly variable from 70 to 225 ft per minute in the standard model, with a special version from 70 to 450 ft per minute. A wide choice of Starrett saws is available to suit the particular material being used. Saw changing is very simple and quick. Standard saws measure 144 in by 1 in by 0·034 in.

A feature of the machine is the automatic selector for the number of pieces cut. There is a counter on the side which can be set to the required number, and when this is reached the saw will automatically stop. Otherwise it will continue to cut until the stock is exhausted. As compared to a reciprocating hacksaw, considerable savings are claimed both in time and in material. *Monks and Crane Limited, Garretts Green Lane, Birmingham 33.*

GEAR HOBBING MACHINE

Up to 8 in Gears



NOW being made in this country is the Lees-Bradner gear hobbing machine model 7HD.

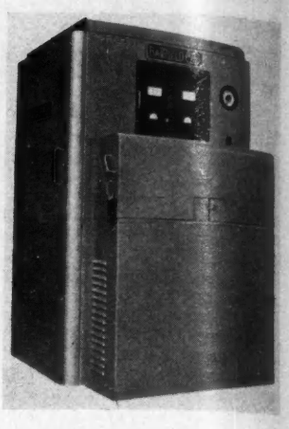
The machine is designed to cut gears up to 8 in diameter using a 3 in hob or up to 7 in if a 4 in diameter hob is used. The rated capacity in steel is for teeth up to 4 dp. The maximum travel (face width) with the standard column is 20 in and with the long column up to 32 in. Corresponding distances between centres are 33 in and 45 in. The maximum helix angle that can be cut is 45°.

Special features of the machine include the antifriction hob head with positively controlled power operated hob shift of 3½ in. The amount is preselected by a graduated ring marked in increments of 0·001 in from 0·005 to 0·040 in. The hob advance button is only operative at the end of the cycle with the main motor stopped, and there is an interlocked hob return button. A counter is set to record the number of cycles between successive hob shifts and when the last is completed a green lamp lights, and after the last hob shift a red one. The interlocks then prevent further operation till the hob has been reset.

Drive is taken from a 10 hp main motor and the hob is mechanically fed by a separate motor. *Precision Gear Machines and Tools Limited, Red Ring Works, Bodmin Road, Wyken, Coventry.*

HIGH FREQUENCY GENERATOR

Silica Envelope Valve



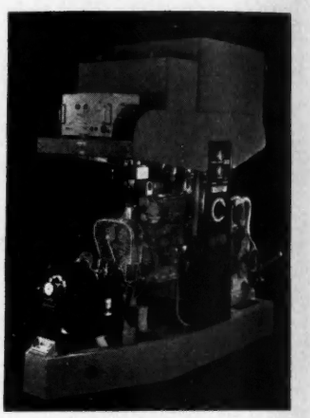
A NEW RANGE of high frequency generators covers outputs from 18 kW to 45 kW in four models.

Silica envelope oscillator valves are used with a guaranteed life of 6,000 hours. They are air cooled with an additional water jacket to obtain the advantages of water cooling without the disadvantage of a special circulating system. Additional cooling is provided by a centrifugal blower. Protection is given by low current anode trips and there is also a sensitive anode current trip operating on an overload time basis.

Ceramic tank condensers are standard items. The transmitter type capacitors have excellent characteristics and are not adversely affected by prolonged current or kVA overloads. Thyratron rectifiers are used which enable operation switching to be controlled by a small relay which alters the bias on the grids; thus the main contactor is used solely as a switch at the beginning and end of the day. The grid controlled thyratron valves also enable a smooth infinitely variable full range power control to be obtained by means of a single knob. As an optional extra multi-station switching can be incorporated. *Wild-Barfield Electric Furnaces Limited, Elecfurn Works, Otterspool Way, Watford By-pass, Watford, Hertfordshire.*

ENGINE TEST SET

For Instruction



A REDESIGNED set of engine testing equipment for schools and colleges, the Mark II, is now announced.

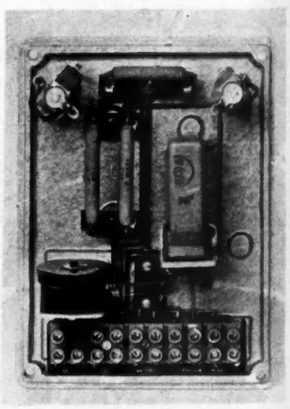
The set has been streamlined to remove projections, and the girder structure removed to allow all round visibility. All instruments are mounted on the panels forming the legs supporting the table platform.

Either a 1,500 cc petrol engine of 2⅞ in bore by 3·5 in stroke, or a 2,200 cc diesel engine of 3·25 in bore and 4 in stroke can be fitted. This normally drives a Heenan and Froude hydraulic dynamometer which is mounted with the engine on a base plate. A Dobbie McInnes Farnboro' indicator is fitted as standard but alternatives are available. Compressed air for the indicator is supplied from a cylinder inside the base frame and an electric pump can be used for low pressure work. Air consumption is measured by an orifice plate and a Kent curved tube manometer. Alternatively a viscous flow meter with a multi-slope manometer can be fitted.

For the petrol engine units a twin tube Amal flow meter measures the fuel consumption, and for the diesel engines a calibrated glass cylinder and stop watch are used. Cooling water flow is measured according to the system used. *Newage (Manchester) Limited, Crossley Street, Gorton, Manchester 18.*

GAS DETECTOR

For Industrial Warning Systems



ILLUSTRATED is the interior of the Sieger Mk. 7 gas detector control unit for remote alarm operation.

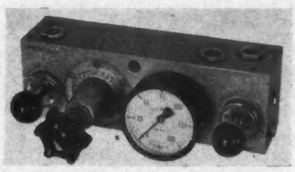
It is designed to operate from a 12 V battery or a dc power supply and is provided with indicator and warning lamps, but it does not incorporate an audible warning device. Instead it is provided with a high speed sealed relay which has contacts rated for 0·5 A, the connections being brought out.

In addition, this new version incorporates a precision potentiometer allowing the sensitivity to be accurately set between the normal threshold of sensitivity of the instrument and the lower explosive limit of the gas in question. The heads supplied with the unit are built to intrinsic safety standards and so are the control box and all circuits used in conjunction.

Special temperature compensation circuits cover ambient temperatures from 14° F to 113° F. Standard heads as supplied with the Mk. 7 instrument are suitable for all explosive gases. Special types are available which are extra sensitive to ammonia gas (1 per cent vol per vol with a commercial tolerance of 20 per cent of that value) or to methane or methane carbon dioxide mixtures. *International Engineering Concessionaires Limited, 39 Parliament Street, London SW1.*

MANIFOLD VALVE

Die-cushion System Control



COMPACTNESS is one of the main claims for the manifold valve illustrated.

The design is intended for use in die-cushion systems for which the valve will control the required rate of pressure to the die-cushion system of a press and will prevent damage to other units if a pressure surge should occur. The overall dimensions are 12 in long by 4 in wide and the centralized positioning of the inlet and exhaust controls reduce operator fatigue. Ports for inlet and exhaust are set at the top and rear of the unit, facilitating installation.

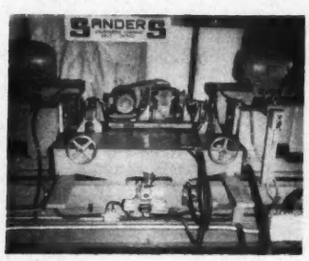
With the inlet valve open and the exhaust closed, the pressure regulator meters the air to the system at the required pressure shown on the gauge. On completion of the pressing cycle the manifold automatically replenishes the die-cushion system with air and so maintains the correct working pressure. The non-return valve locks the pressurized air in the system and prevents surges from damaging the gauge and manifold. The air passages in the manifold have a minimum diameter of $\frac{7}{16}$ in, which ensures a capacity of 100 cu. ft per minute of free air at 80 lb per sq. in differential pressure.

The Bourdon pressure gauge is calibrated up to 150 lb per sq. in in steps of 5 lb. Both inlet and exhaust valves are piston types and can be locked in open or closed positions. Inching of flow is made by a fine adjustment control. Input pressures may be up to 200 lb per sq. in.

The body of the unit is made of high tensile extruded aluminium and there are six ports available for use—three in the top and three in the rear. Blanking plugs are supplied for those not required. All components are made to close tolerances to ensure interchangeability of parts. *Pongrass Brothers (Engineering) Pty. Limited, Myrtle Street, Botany, N.S.W., Australia.*

AXLE FINISHING MACHINE

Single Operation



FABRICATED front axles for the Massey-Ferguson combine are produced in a single operation by a machine of which the work area is shown in the illustration.

The axles consist of 6 in by 4 in welded rectangular tube with flanges and plates added for attachments. The axles are loaded to the machine by air hoist and clamped. The operation is then initiated by push button. The main carriage traverses the axle past the two 8 in diameter inserted-tip milling cutters, each of which is driven by a 20 hp motor. At the same time the motor-driven head on the carriage moves first right and then left to drill the locating holes for the transmission.

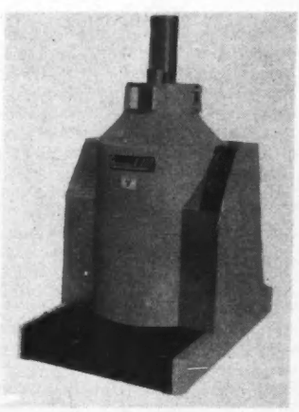
At the end of the stroke the two multiple heads are brought into action to drill the eight holes in the flange and to bore the centre hole for the bearings. When the heads have retracted the machine stops and the operator releases the axle to the rear of the machine, the carriage returning empty for reloading.

The carriage motion is hydraulically operated and has control for fast approach—feed—fast advance to location—and fast return. All motions are steplessly adjustable. Lubrication is automatic, and one cycle takes 5 min.

The heads are fitted with reduction gears for the milling cutters but have direct drive for the boring. They have a flat front face for mounting multiple heads and move on a cast iron sub-base under hydraulic power. Provision is made for operating each head and carriage separately for setting up the machine. Axles ranging from 60 in to 84 in long can be accepted. *L. J. R. Sanders Engineering Company, 34 Ainslie Street South, Galt, Ontario, Canada.*

IRRADIATOR

For Laboratory Samples



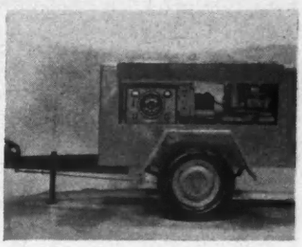
THE Gammacell 220 is a self-contained irradiation unit for general use.

It has a sample chamber measuring 6 in diameter by 8½ in high which is part of a vertical loading drawer, shown in the withdrawn position in the illustration. A split collar is unlatched to load and unload the sample and no manipulators are required. The Cobalt 60 source takes the form of a squirrel cage of up to 54 sealed rods with a diameter of 8 in and height also of 8 in. This is fixed in the body of the machine and provides a uniform field.

The vertically sliding loading drawer in the standard model contains three stainless steel access tubes reaching into the top of the chamber. Two of these are 0·43 in internal diameter and the third is 0·25 in. A fourth tube for drainage leads from the bottom of the chamber. The tubes follow a spiral course and can be used for coolants (liquids or gases) or electrical wiring; for special experiments the tubes can be connected to standard accessories designed for mounting in the sample chamber. A controlled temperature and pressure vessel with its own heater is one example. The chamber lift is power operated and there is a timer for exposures. *Atomic Energy of Canada Limited, Commercial Products Division, PO Box 93, Ottawa, Canada.*

PORTABLE WELDER

Currents up to 400 Amperes



ILLUSTRATED is the Dieseliner 400 arc welding set designed for field operation.

The unit can be supplied as illustrated on a two wheel trailer or, alternatively, mounted on skids. Lock up panels and covers are an optional extra. The generator rating is for 300 amperes at 40 volts for a 60 per cent duty cycle. At normal welding voltages the current is adjustable from 40 to 400 A in ten main steps selected by a switch which is operated by a handwheel mounted on the control panel. A field rheostat provides 100 steps of fine adjustment for each of the coarse ranges.

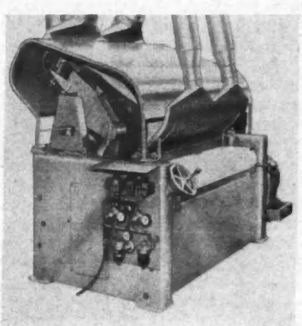
The Hobart generator is the four-pole type with laminated main poles and four interpoles. The single unit brush rigging holds the generator and exciter brushes in fixed neutral position. There is a built-in four pole exciter which is capable of providing an auxiliary power supply of 1 kW at 110 V dc.

The engine is a Perkins P3 four stroke three cylinder water cooled diesel which develops 35 hp at 1,800 rpm. It is fed from a 12 gallon fuel tank. A large industrial design radiator is fitted for cooling. Generator cooling is provided by a Sirocco type blower mounted in an involute housing and located between the main generator and the exciter.

High arc stability is claimed for the welder, and quick build up of excitation. There is provision for polarity reversal by a switch. There is also provision for mounting the voltage and current control on an extension for remote operation from the actual working position. *Broadway Welding Supplies Pty. Limited, 25 Meeks Road, Marrickville, New South Wales, Australia.*

WIDE BELT SANDER

Positive Thickness Control



STOCK thickness can be maintained to ± 0·002 in on the 1000 series wide belt sanders.

Solid stock, plywood or veneers, can be handled on the machines of which there are four models having belt widths of 20 in, 32 in, 44 in and 50 in respectively. In each case the belt lengths are 106 in and the contact roll diameter 17½ in approximately. Belt speeds are 5,400 ft per minute and the minimum stock length that can be handled is 10 in. The feed speed range is from 30 to 90 ft per minute.

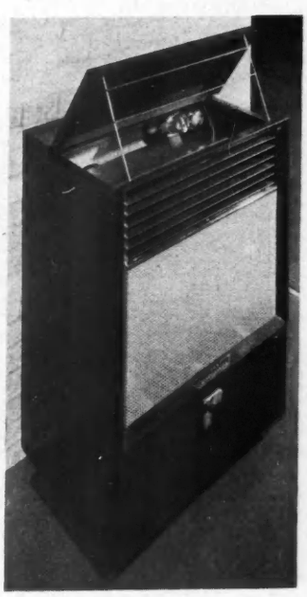
The feed table of the machine is 33½ in high above the floor and is 44 in wide. Floor areas required vary from 80 in by 60 in to 110 in by 60 in for the four sizes.

The motor is mounted separately from the main frame to prevent the transmission of vibrations. The endless belt is rubber based and moves over a precision machined table. The whole bed can be fixed or floating with variable pressure cushioning for sanding or polishing as required. In-feed and out-feed hold-down shoes are closely coupled to eliminate any "dubbing" tendency in short stock.

The air-tensioned idler maintains correct belt tension at the contact line regardless of load, and since pressures and feeds can be varied, the desired finish can usually be obtained without having to change contact rolls. *Preston Woodworking Machinery Company Limited, Preston, Ontario, Canada.*

AIR HEATER

Outside Mounting



DESIGNED to prevent the room oxygen being used up in combustion, the Canadian-made Convexionaire is mounted on the outside of the wall.

The model illustrated is gas fired with an output of 35,000 Btu per hour. The unit is placed against an outside wall and a small vent is located at the back to allow the entry of enough air for combustion and for the escape of gas fumes. Room air is drawn in at low level and expelled from the top of the unit after being heated. The velocity at which the heated air is expelled is said to be enough to circulate a large living space without a fan. Models with capacities of 18,000 and 44,000 Btu per hour are also available.

The unit embodies the Honeywell Adatrol primary gas controls. This line includes pilot safety control, gas valves, manual starting cock, and automatic control valve. Any one item can be removed simply by unscrewing it from the manifold. *Clare Brothers Limited, Preston, Ontario, Canada.*

Malta GC: Workshop of the Mediterranean

Shaping a new life for her industrious people, Malta has a highly effective system of incentives successfully attracting profitable industries of great diversity.

GOVERNMENT factories let at 9*d* per sq. ft, a keen and easily trained labour force, grants or loans for capital costs, a tax free holiday and Imperial Preference these, and a splendid position between Italy of the European Common Market and North Africa, are among the advantages open to industrialists setting up on the island.

While the massive British Trade Fair in Moscow just now breaks all the records for size and comprehensiveness, Malta's fifth Trade Fair, to be held from 1 to 16 July in the pleasant gardens of the Estates of Palazzo Parisio clearly shows the growth of interest in Maltese industrialization. A 50 per cent increase in exhibition space has been necessary and the number of firms taking part is sharply up on last year's one hundred. The Governments of Malta, the United Kingdom, Sicily and the Commonwealth have arranged national pavilions.

Much of Malta's general and industrial history is tied up with the Royal Navy and the dockyard so it is no surprise that much of the country's future depends on the success of C. H. Bailey Limited, the long established South Wales ship-repairing concern who are as active in diversification of their efforts as the individual interests, from car assembly through textiles to plant propagation, now flowing into Malta.

What attracts such international companies as Dowty of the United Kingdom and American Motors, the originators of the United States compact car, to this Mediterranean island of well under 500,000 people? The Malta Government's incentives are comprehensive and efficient. Their outstanding features are given in this table.

Investment Incentives

Tax Free Holiday
No income tax on new industrial undertakings for up to ten years.

Grants and Loans
Loans or grants of up to 33½ per cent or in special cases up to 50 per cent of the cost of fixed capital assets. Grants not repayable and do not exclude the firm from income tax relief. Grants may also be made for the dismantling, shipping and re-erection of secondhand plant and equipment.

Customs Duty Reliefs
Firms granted exemption from duty on plant and machinery and on building materials for the construction of factories. Exemption also granted on raw materials and component parts in special cases.

Customs Drawback Scheme
Import duties on certain raw materials and components used in production not eligible for outright exemption may be refunded on exportation of the product embodying the imported material.

Imperial Preference
Raw material import duties and those on components, etc., are generally low, particularly on those from the Commonwealth under the Empire Preferential Tariff Rates. These are on average 14 per cent lower than the General Tariff.

No Local Taxes
No local government rates or property taxes in Malta.

Industrial Estate
Fully serviced sites provided in perpetuity at the low rent of about 10*s* per 1,000 sq. ft. Standard, ready built factories available at about 9*d* per sq. ft for an initial period of 16 years. New factories built to applicant's specifications.

Bringing the total of companies whose applications to the Aids to Industries Board have been approved up to 21, five new firms have recently joined the list of those starting up or expanding on the island.

These five include a manufacturer of children's clothes; a glove making firm of international repute, Dent, Allcroft (Overseas) Limited, who plan to step up their production in Malta by 50 per cent; a metalware pressing and plating company specialising chiefly in tableware; the import of nylon and Terylene straight yarn for processing into a state suitable for making up into clothing with a high stretch capability; and MCP Melita Limited, who are to make semiconductor devices such as diodes and transistors.

For an island economy relying on its manufacturing capacity and skill to turn imported materials into highly valued exports electronic parts are, in the words of Mr. Joseph Mattei, London Manager of the Aids to Industries Board: " An ideal manufacture for Malta."

The initial employment of this company will be some 50 people, who will all be specially trained, possibly in Britain. Eventually the number of employees is expected to reach 1,500.

Making a similar contribution to the diversification of the island product will be Dowty Seals Limited, part of the Dowty Group of Cheltenham. Their subsidiary Malta Rubber factory will at first employ more than 100 workers, almost half of them women. Two thirds of these will be semi-skilled workers trained in the Malta factory in operating rubber mills, extruders and presses.

A Dowty executive has informed ENGINEERING that key personnel, chemist, works engineer, works superintendent and chargemen have been recruited in Malta and are now being trained in the Dowty Seals factory at Ashchurch, Gloucestershire.

The Dowty project in Malta is intended entirely for export sales. Dowty executives who have visited the island endorse the opinion regarding the good quality of the labour.

There is a useful educational system which is compulsory. English is widely known and good progress is being made in technical and industrial training schemes.

With the increasing demand for labour in the United Kingdom and on the Continent, more and more industrialists will be interested in this useful pool of workers in Malta. Labour rates in countries bordering the Mediterranean are low, being 50 or 60 per cent of those in the UK.

Currency and customs duties present no special problems. Malta is in the sterling area and there are no difficulties regarding the transfer of profits or the repatriation of capital. As Malta belongs to the Commonwealth preferential tariff system, the majority of goods manufactured in Malta have duty-free entry into the UK and, in many cases, receive preferential tariff treatment in other parts of the Commonwealth.

Any assessment of how Malta is making out in industrialization must rest heavily on the progress of the Bailey group of companies in turning the former naval dockyard into a commercially competitive ship repairing and ship building establishment with added engineering interests to give a broader base to the activities of Bailey (Malta) Limited.

One of the difficulties for Bailey's has been that plans for the dockyard have had to be formulated at a time of major change in the design and construction of ships, particularly in the dimensions and tonnage of cargo ships and oil tankers.

The company faced the fact that it was most unlikely that any commercial dockyard depending upon the vagaries of booms and slumps in world shipping, could offer continuous full employment, and plans had to be made in the interests both of continuity of employment and the economic position of Malta as a country, for industries other than ship repairing and building. This is by no means a problem applicable only in Malta as every maritime country in the world has had to give increasing attention to the need for diversification for the same reasons.

Again the problem was first faced as it affected the dockyard, and it was recognized that a wide field of varied types of engineering could be successfully and competitively carried on in the facilities available, with suitable modifications.

The Dockyard itself is now specialising in all forms of oil field engineering, in many cases building and assembling rigs and drills in the Dockyard, and later re-assembling and erecting in other parts of the world. Civil engineering steelwork covers a wide field from multi-storey steel buildings and sheds to bridges and chemical plants; steel fabrication in the dockyard, with modern systems of x-ray and gamma inspection, includes boilers, pressure vessels, tanks,

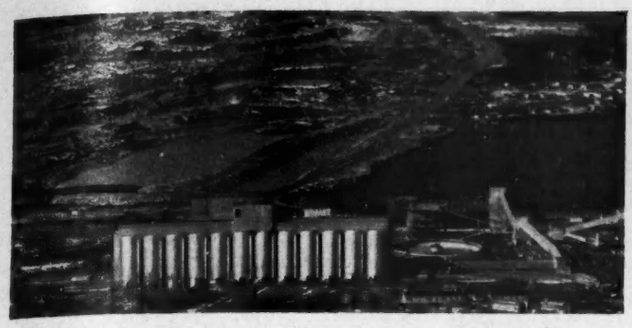
Repairing a floating crane in the Bailey (Malta) floating dock.

pontoons, dolphins and off-shore drill platforms. While many forms of mechanical engineering including milling, grinding, gear cutting, forging, boring, pressing and stamping are carried out for clients in of countries apart from Malta.

It was apparent from the outset that many opportunities existed for industrial diversification and employment which could not be carried out in the dockyard and among several activities associated with Bailey, one Company—BIM Limited (Bailey Industries Malta Limited)—was formed to produce all forms of light engineering and equipment. A new and extensive workshop on modern lines was quickly built and has been operating for almost a year. The items produced are many and varied, ranging from vending machines of an insulated type to supply chilled liquids in hot climates, to Solar Water Heaters, which make use of the thermal power of the sun both for space heating and for the supply of hot water in the hours of darkness. Whether the requirements be for portable bunkhouses for oil exploration crews, patent valves, office and factory furniture and equipment or garden seats, this new light engineering company can supply a suitable and competitive product.

Market research in engineering development showed at an early stage the need to cater for sub-tropical and tropical climatic conditions, and in this connection it was recognized that there was a great demand for thermal and incidentally, acoustic insulation, which could be supplied from Malta. Another company was therefore formed in association with a British firm, Jablo Limited, to produce new materials, such as polystyrene and other modern insulants.

Apart from their own activities, Bailey have played a part in encouraging other industrialists to assist in the drive for an economically independent Malta, sometimes participating and in other cases providing the benefit of their experience to firms already established in Britain and elsewhere.



An aerial view of the Lac Jeannine mine and concentrator last autumn. More than 300 million tons of ore are expected from this mine.

Port Cartier. Ore carriers of up to 100,000 tons can operate from here to ports in the United States and Europe.

Now Canada is Ready to Produce Iron Ore

Quebec Cartier's new iron ore project is on the point of coming into operation. Concentrates will be carried over a 200 mile railway to a new port on the Gulf of St. Lawrence.

After six years of exploration and planning and three years of construction, a $300 million project to bring iron ore riches from Eastern Canada's Quebec-Labrador Trough to the steel mills of North America and Europe has virtually reached completion. Shipping port for the ore is the new artificial harbour of Port Cartier, suitable for ore carriers of up to 100,000 tons.

Port Cartier is on the Gulf of St. Lawrence, 600 miles downstream from Montreal. Linked to it by 193 miles of single-track railway is a new mine and concentrating plant capable of an annual output of 8 million tons of concentrates per year. Mine, concentrator, railway and port have been developed and are owned by the Quebec Cartier Mining Company, a wholly-owned subsidiary of United States Steel Corporation. It is believed to be the largest single mining project ever undertaken by one company in Canada.

Quebec Cartier's mine is situated beside Lac Jeannine at the southern tip of the Quebec-Labrador Trough. The concentrator is nearby, and also the attendant hydroelectric power installation on the Hart Jaune River, with 60,000 hp capacity.

The railway to Port Cartier was not completed until just before Christmas, and little use could be made of the port until recently, when the interior basin was flooded. This meant that most of the equipment for the project had to be landed from ships at a temporary harbour just to the east of Port Cartier. All the equipment for mine and concentrator was trucked north from the temporary port along the access road to Lac Jeannine, or flown in to an airstrip just north-west of the mine site. Local haulage contractors described the casualty rate among vehicles as " fantastic."

There must have been a variety of considerations that led to US Steel's decision to go ahead with the Canadian development. But it is believed that among the more important were the following. The Canadian ores were soft and easy to process. Development costs in Quebec-Labrador were high but the economics of the project were enhanced by the scale of the development and the presence of vast reserves held by the company in the same area. The geography of the project in Canada allowed a Gulf of St. Lawrence Port, bringing the concentrate within economic shipping distance of East Coast United States ports. Europe and Great Lakes harbours. Canada has more lenient allowances than the USA for depreciation in such huge projects. Possible political difficulties in Venezuela made alternative development there less attractive.

At the Lac Jeannine mine itself, more than 300 million tons of ore have been outlined. At the company's holdings a few miles north at Mount Reed, and again at Mount Wright, about 70 miles north-east, there are further vast deposits. Quebec Cartier officials won't hazard a guess at a possible total, but men in the industry say that a total of about 1,000 million tons or more may be proved.

At Lac Jeannine, the deposit consists of specular hematite ore, extending over an area 8,000 ft long and 2,300 ft wide. Downward extension exceeds 1,000 ft. It could become one of the deepest iron ore mines in North America. The mine is designed to have a maximum production of round 20 million tons annually. Extraction is by open-pit methods and a fleet of thirty-six 40 ton capacity trucks move the ore to the concentrator nearby. In its natural state the ore contains 30 per cent iron, and the concentrator upgrades this to 66 per cent iron. The low-grade ore is blasted into lumps at the mine, before being loaded on to the trucks.

CONCENTRATOR PLANT

Basically, the ore is ground by rolling on itself in revolving drums. Most of it is soft enough to break into sand-sized crystals without the addition of grinding material. Oversize material goes back into the drums. Purifying of the ore is effected by the Humphrey Spiral system. As the material flows in water around several thousand of these spirals, the heavier iron settles and the impurities flow away. The ore is delivered by the trucks to the crushing plant at up to a rate of 60,000 tons a day.

From the concentrate bins, the material passes through a drying operation before passing to the railroad load bins. Reducing the moisture content of the concentrate to near zero improves handling qualities and is particularly important for shipping in the coldest winter weather.

Just before Christmas, the first trains traversed the track between Port Cartier and Lac Jeannine. Since then all supplies—including those for the mushrooming town site at Gagnon near the mine, have been carried along the single track. For the railway, operation as an all-weather line will be carried on throughout the year.

While the port could be used all the year round if circumstances dictated, ore shipments will probably halt during the most severe two or three months of winter. At this time, while thin ice in the port could easily be broken, ships would probably need hull strengthening for navigation in the Gulf.

Loaded trains pull into the yard at Port Cartier along the dumper track directly to the dumper. The locomotive units run through the dumper cradle. They are then cut off and moved to the diesel shop for servicing. Meanwhile an automatic hydraulic pusher mechanism at the dumper takes over movement of the cars. When the last car has been dumped, the dumper automatically shuts off, leaving the caboose on the dumper cradle, where it is serviced. The cycle at the ore dumper is about 80 sec: forward one car length, dumping, and back into position ready for the next forward push. It takes 2¾ hours to empty an entire train. Each ore car has a capacity of 100 tons, thus the whole train of 125 cars has a capacity of 12,500 tons.

Location of the harbour was chosen so that the port can be used all the year round by large ships if need be. The site of Port Cartier is at a spot where ice does not seriously jam up. The harbour is a large basin carved out of rock with a narrow inlet and protective wall; breakwaters extend into the open sea to reduce swell action. The interior basin is designed for berthing facilities for four iron ore carriers of 100,000 tons capacity each.

Total length of the basin is 2,500 ft, total width 450 ft. The total excavation required was more than 7 million cu. yd, and 80 per cent of it was rock. The area of the basin is 1,125,000 sq. ft, and minimum depth at low tide is 50 ft, adequate for the largest ore carriers now planned.

After dumping, the ore concentrate goes through a " grizzly " and the lumps caused by compaction in transit (or by frost in winter) pass through a rotary crusher and then by conveyor belt to an ore storage shed or directly to the shiploader. The system of conveyor belts is controlled by one operator located in an enclosed cabin at the end of the shiploader boom. A surge bin of 1,000 tons capacity enables the operator to stop loading for a few minutes—for changing hold in a ship for instance—without stopping the main conveyor systems or affecting car dumping operations. The port facilities have installed capacities at present for unloading rail cars at up to 4,040 tons an hour, and loading ships at up to 5,050 tons an hour.

It may make Canadians sensitive that there is no Canadian participation in Quebec Cartier, as in Iron Ore Company and Wabush Iron Company. But Canadians have to ask themselves whether they would have put up perhaps close to $400 million for a single project. Also it is believed that there are upwards of 10,000 million tons of ore awaiting exploitation in Northern Quebec and Labrador—leaving plenty of scope for the future.

This year nothing like maximum capacity of ore will be produced from Quebec Cartier's operation. A large proportion of this year's production will go to US Steel's own mills, where it will be put through an exhaustive series of tests. Almost certainly some of the concentrate will be tested for its adaptability for direct-reduction steelmaking, the process which by-passes the blast-furnace stage.

Canadian iron ore output has risen from 3 million tons annually in 1950 to the present level (about 20 million tons), and is expected to be almost double again by 1965. It could reach between 60 and 70 million tons by 1970. Obviously much will depend on whether markets will expand as much as Ottawa forecasters expect, but if these figures are achieved, Canada will probably be the world's largest exporter of iron ore by 1970, and one of the largest producers—perhaps coming after only Russia and the United States.

Civil Engineering in the Commonwealth

The volume of civil engineering in progress in the Commonwealth is beyond computation. In the following pages are brief descriptions of a number of works, some large, some small, but all important to the areas they will serve.

THE examples of civil engineering work described in the following pages form a cross-section of the vast volume of work now in hand in the Commonwealth. Some of the examples represent large contracts that have been in progress for several years; others are relatively small, but all of them involve interesting solutions to design problems and all of them will help to improve the lot of the community in which they are located. On many of them, too, local men will receive training and experience in the design and execution of works, in handling plant and equipment, and as tradesmen.

The Duke of Edinburgh, in his Graham Clark Lecture "The Engineer in Commonwealth Development," referred to some of the great projects. He pointed to Australia's desperate shortage of water and the potential of the Snowy River Scheme to meet immediate demands for energy and irrigation. Though there were virtually no other hydro-electric sources in the continent he observed that she fortunately possessed considerable resources for the production of nuclear energy.

Of New Zealand, the Duke pointed out that they had fairly large reserves of water power and were building many dams and installing extensive power producing plant. He referred to the cable crossing that is to be made across the Cook Straight to carry the power to the more populated North Island and to the harnessing of geothermal steam.

In Canada, too, there are many great works in progress for the production of hydro-electric power and there is also under construction the great trans-continental highway. In Ghana, the contract has just been awarded for the earth and rock-fill dam on the Volta River that will provide power for the aluminium smelters to be built near by. The contract has gone to Impresit, the Italian consortium who built the Kariba dam on the Zambesi that has given such a great stimulus to the industries of the Federation of Rhodesia and Nyasaland.

Prestressed Concrete Footbridge in Ceylon

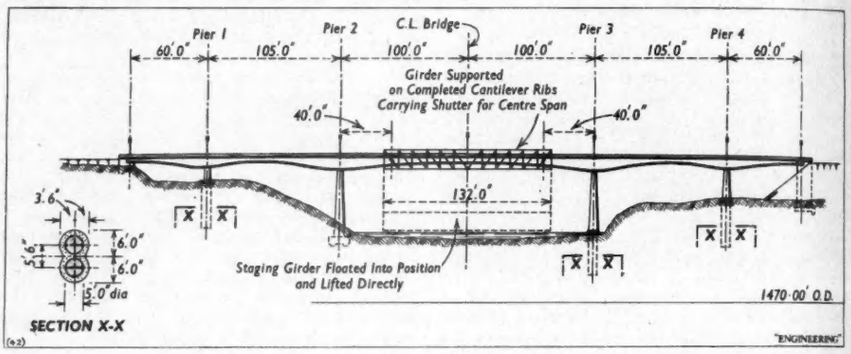
The University of Ceylon was established in 1942, incorporating two former Government Colleges.

At the end of the Second World War, the Public Works Department commenced the development of a University Park on the banks of the Mahaweli Ganga, Ceylon's largest river, at Peradeniya, near Kandy. Buildings for a faculty of engineering are being built on the opposite bank to the main university site and though this is served by a main motor road, it has been necessary to provide direct access across the river for foot and cycle traffic, and occasional light vehicles.

The bridge, which is now under construction, is founded on deep concrete cylinders sunk through the river bed down to solid rock, with tall reinforced concrete piers anchored to the cylinder caps.

The superstructure comprises five spans giving an overall length of 530 ft. The central opening is 200 ft between piers and includes a freely supported section of 120 ft. The whole superstructure is in prestressed concrete, all of which will be cast *in situ* and post-tensioned. The end spans are continuous over the piers with cantilevers projecting into the river for supporting the central suspended span.

Since the bridge is only 11 ft wide, the main girders are used as parapets and the cross-section is generally of H-section, with varying



projections below the deck to suit the curve of the bridge soffit. Provision is included for water mains and sewers that are to be concealed below the deck.

Since the Mahaweli Ganga is subject to severe floods, with very rapid and large variations of water level, the shuttering for the centre section will be supported by a pair of temporary girders designed to span between the completed cantilevered ends, as shown in the drawing. These staging girders are designed in standardized demountable sections to permit their use for the shore spans, and also for future bridge works of this type.

The works have been designed and supervised by Husband and Company for the Director of Public Works, Ceylon. The consultants have an established office in Colombo and have for several years given training facilities for Ceylonese engineers seconded by the PWD and other Government departments. The contractors are Walker, Sons and Company Limited, Colombo.

Consulting Engineers: Husband and Company, 58 Victoria Street, London SW1.

The Indus Basin Projects

From time immemorial the population of the Punjab in Northern India has existed on the crops which can be grown as a result of the irrigation made possible by the five rivers of the Punjab, which are (from west to east), the Indus, Jhelum, Chenab, Ravi and Sutlej.

In 1947, when Pakistan and India became separate states, the boundary line was drawn up on an alignment which resulted in the headwaters of the Rivers Ravi and Sutlej being in India, whereas most of the areas irrigated from these two rivers were in Pakistan.

The populations of both countries are increasing rapidly, and both need all the water they can get. India is in a strong position as she can divert the waters of the Rivers Ravi and Sutlej before they reach Pakistan; in fact the Bhakra Dam on the River Sutlej had been started before partition and is large enough to withhold all the water of that river, apart from exceptional years. Further dams are proposed by India on the River Beas, a tributary of the River Sutlej, and on the River Ravi.

The population of Pakistan and its need for water is now too great to adopt the old remedy whereby the inhabitants were moved to new cultivable areas where water could be made available, as all land which can economically be irrigated is already occupied. Fortunately, the two most western rivers, the Indus and Jhelum, have a surplus of water at certain times of the year.

Dams are therefore to be built on both these rivers to store this surplus water and incidentally to generate electricity as the water is drawn off for use. These dams are Tarbela on the River Indus and Mangla on the River Jhelum.

The next problem is to get this water to the inhabitants living on the two eastern rivers who would otherwise soon be living in a desert. For this purpose, it will be necessary to construct barrages in these rivers and huge canals to convey the water from each barrage to the next river to the east, where another barrage has to be built to pass the water on. The barrages are necessary as each of the rivers regularly come down in flood for a few days every year and would wash away any lesser structure which blocked its course. Some of these barrages will be nearly a mile long.

Many of the canals are to be over 100 yards wide and most will be 12 ft or more deep.

The annual flooding of the land in the past has resulted in the subsoil water level rising until in many areas crops can no longer be grown; so the electricity generated by the dams is going to be used in tube wells to pump down the subsoil water and deliver it back to the many smaller canals in the Punjab from which it will again be used for irrigation.

The cost of the whole project will be vast, of the order of £300 or £400 million, and it will take ten to twelve years to complete. Much of this money is being provided by grants from Great Britain, the United States, Germany, Australia, Canada, New Zealand and India, as well as by a loan from the World Bank, though Pakistan will also find some from her own resources.

The work is now in the detail planning stage in the hands of British and American consulting engineers and it is hoped to let the first contracts in the early part of 1962.

Consulting Engineers: Coode and Partners, 2 Victoria Street, London SW1.

Escravos Bar in Western Nigeria

In February, 1959, Richard Costain Limited, in association with Raymond International, were awarded a contract valued at £8 million for the construction of a 6 mile long mole and separate island mole at the mouth of the Escravos River in the Bight of Benin, Western Nigeria. The contract is being carried out for the Federal Government of Nigeria. Work on the main mole construction started in the autumn of 1960.

The intervening period was occupied with the preparatory work, which included the location of a suitable quarry; surveys of the route between the quarry and the site of the mole, and of intermediate loading points; choosing

sites for European and African housing; and the ordering of plant, some of it specially designed.

The total quantity of stone required for the two moles amounts to about 1½ million tons. Eventually a site near Ore in the Ondo division of Western Nigeria was explored and found suitable for producing stone of the required quality, quantity and size. It is 145 miles from Escravos.

The quarry is worked by coyote hole methods, and the stone is handled by cranes and face shovels. At Ore, a small township has been built for 30 Europeans and 300 Africans.

At Escravos, the rock trays are transhipped to 700-ton capacity seagoing barges. Placing the stone is done by a 15/25 ton Butters electric crane mounted on a submersible pontoon—a specially designed piece of plant built in Holland. The pontoon crane, the "Cormorant," is now working at the seaward end of the mole, cross beatings from two radar beacons being used as an aid to the accurate placing of the stone.

Altogether, plant to the value of nearly £2 million has been assembled to carry out the contract, including diesel hydraulic main line locomotives, shunting engines and rolling stock, derricks, a 15-ton level luffing wharf crane, electric generators and crawler excavators.

Consulting engineers: Coode and Partners, 2 Victoria Street, London SW1.
Contractors: Richard Costain-Raymond International, 111 Westminster Bridge Road, London SE1.

Port Mann Bridge in British Columbia

John Laing and Son (Canada) Limited, a subsidiary of the British company, is engaged on a $4 million project for the construction of reinforced concrete piers, a railway trestle and various ancillary works for the Port Mann bridge in British Columbia. When completed, this four-lane bridge will carry the Trans-Canada Highway over the Fraser River 15 miles east of Vancouver. The work is being carried out for the Government of British Columbia (Department of Highways) and is due for completion by the end of this year.

The new bridge will have a centre span of 1,200 ft, with a clearance of 145 ft above high-water level, and 360 ft approach spans. The overall length of the structure will be about 6,900 ft.

Work on the piers of the north approach, which forms the major part of the Laing contract, consists of an abutment resting on the embankment section, thirteen land piers and seven water piers. Similar land piers and an abutment have also been completed on the south approach and the reinforced concrete railway trestle, on precast concrete piles, will be constructed on this side of the river during the summer. The land piers are founded on expanded-base Franki piles, varying in number from 18 to 44 for each base. Reinforced concrete pile caps, 6 ft thick, are used to spread the column loads to the piles. All the columns are rectangular, hollow, and tapered from bottom to top on one pair of faces.

The seven river piers are enclosed in elliptical coffer dams of varying sizes, the largest being 132 ft by 44 ft. Within the coffer dams, 16 in steel pipe piles, filled with *in situ* concrete and with an average driven length of 40 ft are required. The pile cap, 30 ft under water, is 10 ft thick and heavily reinforced.

Upon completion of the foundation work for a river pier, the sheet piles are cut off at the top of the pile cap and scour protection is obtained by excavating 10 ft deep by 60 ft wide around the cap and placing rock of varying sizes to form an inverted filter.

Consulting Engineers: CBA Engineering Limited, 4545 Main Street, Vancouver.
Contractors: John Laing and Son Limited, Mill Hill, London NW7.

Guma Valley Dam in Sierra Leone

Taylor Woodrow (Sierra Leone) Limited began work in April on a £2 million contract, awarded by the Crown Agents for Overseas Governments, for a 900 ft long earth dam in the Guma Valley. Howard Humphreys and Sons are the consulting engineers. Work will be finished by 1965.

The dam will hold back 4,400 million gallons to augment the water supply of Freetown, the capital of Sierra Leone (and also supply a possible future hydro-electric station).

At its highest point, the dam will rise 190 ft above the river bed. The site, as the accompanying artist's impression shows, is a narrow steep-sided gorge in the mountainous forest reserve area, near the villages of Hamilton and Sussex, and about 16 miles by road south of Freetown. The area to be cleared before flooding amounts to 230 acres, mainly thickly wooded. Some

1¼ million cu. yd of fill material will be used in the construction of the dam. Excavation from the bottom of the dam and from the cut-off trench will amount to about 350,000 cu. yd.

Construction of a forebay, culvert, diversion tunnel and spillway are among the works to be carried out, together with a valve shaft with draw-off pipework at the site of an existing outlet tunnel. The diversion tunnel will be of 16 ft diameter and 1,200 ft long.

In 1957 Taylor Woodrow completed their part in the earlier phase of the water supply scheme, including a 2 million gallon reservoir at Freetown and a 10 mile pipeline leading to it from the Guma Valley capable of carrying 6 million gallons a day.

Although Freetown has a mean annual rainfall of about 150 in, dry season water shortages are always a possibility due to the fast run-off and heavy evaporation. The Guma catchment has a mean annual rainfall of over 250 in.

Consulting engineers: Howard Humphreys and Sons, 8 Francis Street, London SW1.
Contractors: Taylor Woodrow Limited, Southall, Middlesex.

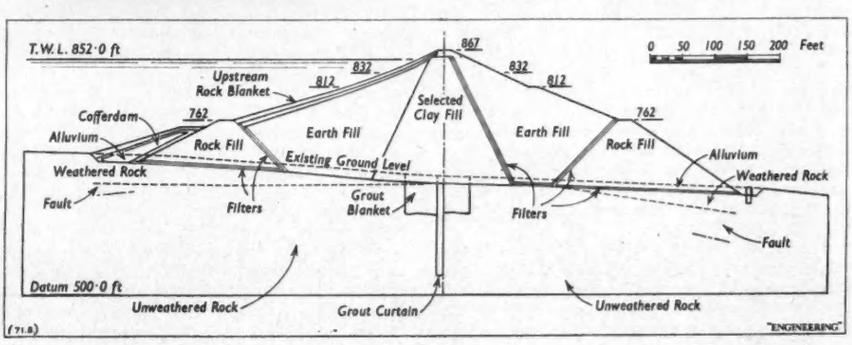
Narmada Valley Project in North-west India

Laying the foundation stone of the Narmada Valley Project by Premier Nehru on 29 March last began the work of tapping the vast economic potential of Gujarat State, North-west India. This scheme, entailing an outlay of Rs 93 crores (£68 million), is designed to irrigate two million acres of land, generate 375 MW of continuous power or 625 MW at 60 per cent load factor, and serve as an inland waterway.

Along its 815 miles from Amarkantak in the Maikhala range in Vindhyas to Broach, where it joins the Arabian Sea, the Narmada river, drains an area of 35,978 square miles. With a total of fifteen schemes envisaged on the river, it offers a power potential of two million kW and an irrigation potential of five million acres. Farming is the backbone of 70 per cent of the population of this basin with a cultivable area of approximately 14 million acres, though only 11 million acres are currently tilled. There are nearly 700 factories, three-fifths of them concerned with textiles. The occurrence of crude oil gives an added importance to this area.

The Navagam project now begun requires in its first phase the construction of a gravity dam 4,600 ft long with a maximum height of 220 ft. It will divert 9,500 cusecs to irrigate about a million acres in the Broach and Baroda districts. The dam will be raised in the second stage to extend the irrigation through the Narmada high level canal to the adjoining Mahi and Sabarmati basins, so irrigating a further 900,000 acres and making possible the generation of electrical power.

The length of the main canal and distribution branches will be 213 miles. It is estimated that the additional annual yield of food crops, cotton, sugar cane and other perennials will be 334,700 tons, 48,900 tons, 356,000 tons and 350 tons respectively. A feature of this project is that the problem of rehabilitating people uprooted from land and surroundings which will be submerged is negligible.

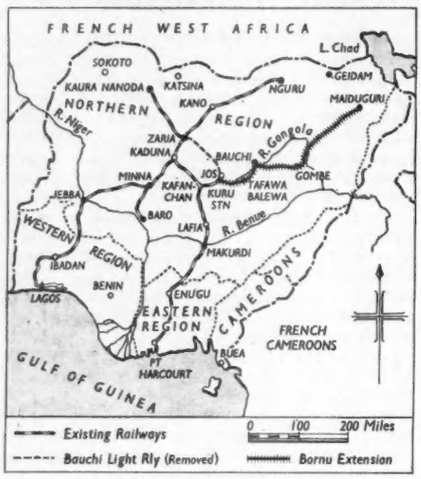


Bornu Railway Extension in Nigeria

The Nigerian Government Railway undertaking was commenced in 1898. By 1955 the railway had increased to 1,780 route miles of 3 ft 6 in gauge line and 133 miles of 2 ft 6 in gauge. In October of that year, the assets and liabilities of the Government railway undertaking were vested in the Nigerian Railway Corporation, a statutory body.

The north-eastern provinces of Bauchi and Bornu, where three million people lived at subsistence level on good agricultural land, were poorly served by the railway, and the road system was inadequate to evacuate surplus produce to any large degree. Various proposals for railway development in this territory had been examined from time to time, and at the end of 1954 it was decided to carry out a traffic survey of possible extensions in this area.

As a result of the survey, the consulting engineers were approached in August, 1955, to carry out a reconnaisance of four possible alignments to extend the railway to Maiduguri in Bornu Province. By making extensive use of aerial photography, they were able to produce an interim project report and rough guide estimate by March, 1956. With the aid of this report and their own traffic survey, the corporation decided that a final location survey should be undertaken, and requested the consulting engineers to do this in August, 1956.



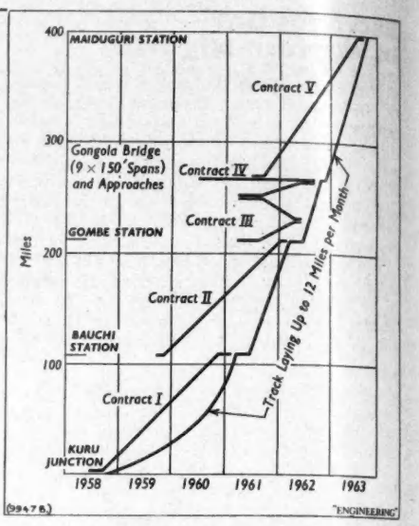
Once again extensive use was made of photogrammetry to produce rapid results, and the completion peg of the survey, at the end of approximately 408 miles of railway route, was driven on 2 November, 1957.

The Nigerian Railway Corporation were able to interest the International Bank for Reconstruction and Development in the proposed Bornu Extension, and decided to press on with the project. While the survey was still in progress, tenders were called for the first 108 miles of the new railway, up to Bauchi, and work commenced in May, 1958. Tenders for the second major contract, for the next 100 miles to Gombe, were accepted in August, 1959, and for the third (Contract IV), the construction of a bridge of nine 150 ft spans over the river Gongola, at the end of May, 1960.

With a view to encouraging local contractors, the section between Gombe (the end of Contract II) and the river Gongola (approximately 55 miles) was divided into three sections, and the earthworks and station buildings on these sections made into separate contracts confined to Nigerian contractors. Tenders for these have recently been accepted by the Corporation. The programme for the work is shown in the accompanying diagram.

The Corporation are carrying out their own tracklaying, and the programme for the work has been designed so that each contract shall be completed before the tracklaying reaches that point. The line has been designed for haulage by diesel locomotives, the maximum gradient being 1·5 per cent compensated and the minimum radius of curves being 6°.

Construction of the 400 mile extension from Kuru to Maiduguri requires about 11¼ million cu. yd of excavation, of which about 250,000 cu. yd are in rock. Some 7 million cu. yd of earth are required for the construction of embankments.



The construction traverses a region with an annual rainfall varying from 60 in on the Central Plateau, to 20 in at Maiduguri, most of which falls in the summer months June to August. The terrain varies from steep rocky areas with a high run-off to sandy parkland with high absorption. A total of 1½ miles of bridged waterway is provided in over 70 bridges with steel spans varying from 20 ft to 150 ft in length and a gross tonnage of about 2,200 tons, of which about 1,700 tons is new steelwork, the remainder being obtained from renewals on the existing system. Over 800 culverts are to be provided, varying in size from 1 ft diameter pipe to multi-barrelled reinforced concrete slab culverts of up to 10 ft span. Construction of the culverts, bridge piers and abutments requires about 124,000 cu. yd of concrete.

Main stations are being constructed at Bauchi, Gombe, Buni and Maiduguri, and there will be 27 intermediate stations in the first phase. The total area of station offices and installations, residential and office accommodation is about 300,000 sq. ft.

Consulting engineers: Rendel, Palmer and Tritton, 125 Victoria Street, London SW1.

Wairakei Geothermal Project in New Zealand

Wairakei lies roughly in the centre of the North Island of New Zealand in the thermal belt which extends approximately in a north-easterly direction from the active volcanoes Nguaruhoe and Ruapehu to the Bay of Plenty and on to White Island. The Wairakei geothermal steam power project is being developed from this geothermal steam to augment the electricity supply and the project is sponsored by the New Zealand Ministry of Works. As at present envisaged at least 250 MW of plant is to be installed. The total cost of the development, which includes the bores, is estimated to be somewhat over £20 million. The area to be "tapped" is of the order of a square mile, the most distant bore being about two miles away from the power stations.

Two turbine houses forming the "A" station to have a total installed capacity of about 100 MW have already been built and the construction of a third turbine house, which will hold about 150 MW for the "B" station, is now proceeding. As compared with a modern coal fired steam power station, the turbine houses are large relative to the capacity of the plant installed.

The steam as it comes from the bores is very wet and most of the water is separated out at the bore head. This water still contains considerable heat energy, and a test plant is now being installed to "flash" the hot water, which is now piped to the power station separately from the steam, and develop power from the steam so produced. It is hoped to increase the power by 50 per cent of that produced from the separated steam.

The site of the power stations at Wairakei is beside the Waikato River, the river water being used for condenser cooling. The ground material consists of pumice silts and sands and the results of volcanic ash showers, and these materials extend down to a considerable depth. Early investigation showed that the load bearing capacity of these materials was low and improved little, if any, with depth, and no underground strata has been located which is suitable for founding piles. Foundation loads had therefore to be kept to a minimum and spread over as large an area as possible. To do this the foundations have been designed as a deep cellular reinforced concrete raft. This arrangement not only effectively keeps the foundation pressures very low, but also reduces the relative settlement of the items of plant within one building to a minimum. The first two turbine houses of "A" station, which are interconnected by a large number of steam pipes, are on one raft 200 ft square by 14 ft 6 in deep. "B" station is to have a separate raft foundation—240 ft long by 90 ft wide by 14 ft 6 in deep—and consists of one turbine house. The foundation conditions at this site were further complicated by the fact that, at a later date, it was intended to develop a hydro-electric reservoir on this length of the river which would raise the water table under the power station. The whole of the areas under the rafts were consequently excavated down to the existing water table (11 ft 6 in below the level of the concrete) to remove the material which was of such a nature as to be liable to considerable settlement when inundated. Gravel, which was thoroughly consolidated as it was placed, and which after compaction would be little affected by the raising of the water table, was then placed up to the foundation level.

The nature of the volcanic material of the area has also affected much of the extensive earthworks involved in the pipe tracks. The pumice materials are very light, in fact a proportion floats on water, and any water flow results in rapid and deep scour. On a flat area where the water can soak away the problem is not serious, but on the cuttings with appreciable grades, concrete lined drainage channels have to be used throughout, and the water intercepted so as to get it into the drains as quickly as possible. On the steeper grades such as where the pipes have to pass a cliff, the whole formation of the cutting has to be protected with concrete.

Consulting Engineers:
Civil Engineering: Sir Alexander Gibb and Partners, Queen Anne's Lodge, London SW1.
Electrical Engineering: Merz and McLellan, 32 Victoria Street, London SW1.

General Hospital in Trinidad

The island of Trinidad is undertaking a five year programme to build adequate modern hospital facilities. Four years ago, when the present government took office, Mr. Elidir Davies, F.R.I.B.A., of Devereux and Davies, the London architects, was consulted and on his recommendation an expenditure of £2½ million was authorized for this programme. Mr. Davies's firm act as consultants for the whole programme.

Port-of-Spain's new Maternity Hospital, recently built by Holland & Hannen and Cubitts (Trinidad) Limited, marks an important stage in this programme, which is now within sight of completion.

Already built by Cubitts are a new nurses training school and a hall of residence for 60 student nurses at San Fernando. Cubitts are also currently working on another of the largest projects in the programme, a 500-bed ward unit at the general hospital, Port-of-Spain, including an operating block with four theatres and a central sterilizing department. They have also built a new out-patients department.

The maternity unit, which cost $1¼ million has 150 beds and was built in 18 months. It is designed with three important features: simple layout, so that internal changes can be made at any time to suit changes in medical practice; a central sterilizing department, entirely self-contained, for all medical instruments, syringes and equipment, which will save the medical staff considerable work in the wards and cut down the risk of cross infection; and mechanical washing and sterilizing equipment for all feeding equipment, bedpans, etc., with the additional use of disposal containers for all non-returnable goods.

The maternity hospital, standing in the north-east corner of the general hospital grounds, is a four-storey concrete-framed building. It has a variety of window patterns overlooking the hospital grounds, and its own vehicular and pedestrian entrances.

On the south side is a single-storey building with a covered waiting terrace for patients and a refreshment bar. Ahead of this lie the administration and records departments from where patients proceed to doctors' consulting rooms and examination cubicles. Sluice rooms and lavatories make this a complete self-contained out-patients department.

The main entrance to the maternity hospital lies on the north side. The entrance hall has low ceilings, mosaic topped tables and benches, and is decorated with murals. Leading off to the right are administration offices, private consulting rooms and a lecture theatre which can be used by the out-patients department or the maternity unit.

Two bed-lifts on the west side carry patients to the top floor, where there are six private single-bed wards, each with its own private balcony, nursing facilities and lavatory. At the building's eastern end are two 24-bed pre-natal wards, with two additional two-bed wards. Each ward has its own nursing station, treatment room, doctors' room, sluice rooms, kitchen and separate lavatories for patients and staff.

On the ground floor is a premature ward, with special glass-fronted air-conditioned nurseries attached. This ward has full accommodation for nursing and lay staff.

The reception area of the delivery department is on the first floor with direct access to the delivery ward which has eight delivery cubicles. Also on this floor is a separate operating suite with anaesthetic rooms, changing rooms and sluice rooms. Adjoining is accomodation for the training department.

On the second floor there is a semi-private amenity ward consisting of a group of six two-bed wards. On this floor are also two post-natal wards with 24 beds each and adjoining nursery areas. Against the bay windows are free-standing babies' baths, where mothers wash their babies. Both wards are provided with separate medical and domestic service rooms.

Contractors: Holland & Hannen and Cubitts (Great Britain) Limited, 1 Queen Anne's Gate, London SW1.

Deep Water Harbour in Barbados

On 6 May, 1961, Sir Grantley Adams, Prime Minister of the West Indies Federation, opened the Deep Water Harbour at Bridgetown, Barbados. This will bring to completion a project, the construction of which started in 1957 but which in fact was first considered as far back as 1883 when Sir John Coode, founder of the present firm of consulting engineers for the project, Coode and Partners, submitted a report to the Government of Barbados for a deep water harbour in Carlisle Bay. Further reports were submitted by Coode, Son and Matthews in 1912 and by Coode, Vaughan-Lee, Frank and Gwyther in 1948, but on each occasion the scheme was either considered uneconomical or funds were not available.

In November, 1955, however, the Government of Barbados decided to proceed with the construction of the harbour and instructed their consulting engineers to prepare the necessary contract documents. Tenders were invited on an international basis and the contract awarded to Richard Costain Limited of London in 1957 for completion by August 1961, at a price of £3,680,000.

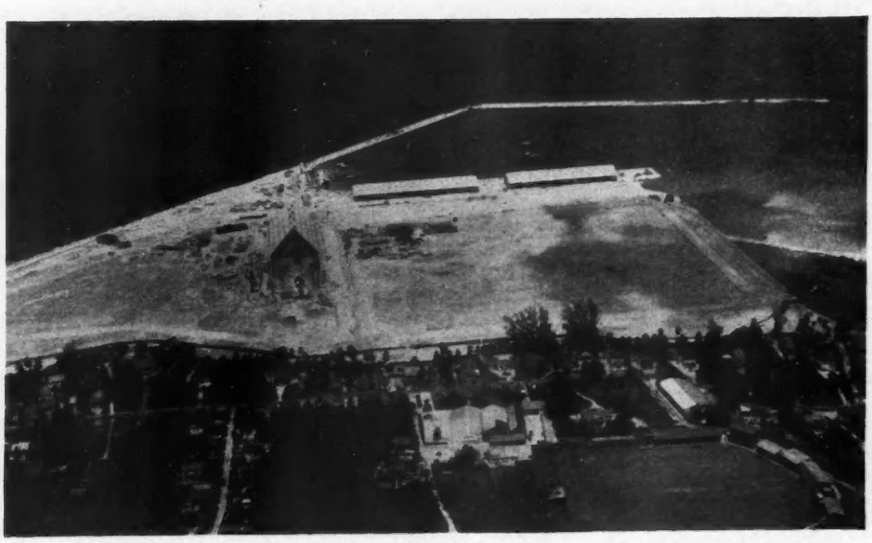
An aerial photograph of the deep water harbour, nearing completion, is shown in the illustration. Shelter for the harbour area of some 40 acres is provided by the breakwater, the inner arm of which is 1,006 ft and the outer arm 1,712 ft long. The breakwater is constructed of precast concrete blocks, having an average weight of 15 tons, set in sloping bond on a rubble base, with a mass concrete superstructure of 30 ft width along the outside of which is an elevated promenade and parapet wall. The breakwater provides berths for three tourist ships along the outer arm, and for a sugar export vessel and a molasses vessel, or any other two vessels, along the inner arm.

The quay wall is 1,211 ft long, providing two berths each of 600 ft for cargo vessels, and the quay wall can be extended, within the shelter of the breakwater, to provide a further two berths at a later date. This wall is also built of precast concrete blocks, set in sloping bond on a rubble base. The breakwater and quay wall are provided with the usual bollards, fendering, water and fuel oil bunkering points. Two transit sheds of 425 ft and 475 ft length by 90 ft width have been built behind the quay wall. Between the root of the breakwater and the quay wall an inner berth, 500 ft in length, is provided for coastal steamers and schooners. The depth alongside the quay wall and breakwater is 32 ft below LWOST.

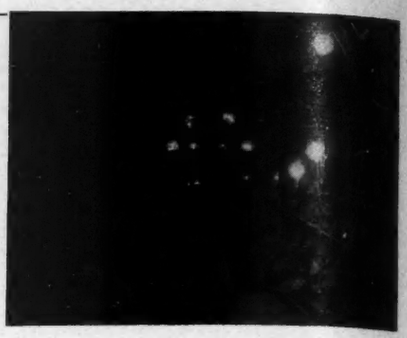
The material, finger-type coral and sand, dredged from the harbour area was pumped behind the quay wall to provide a reclamation area of some 87½ acres, this area being protected on the north and south sides by rubble banks. A total of 1,700,000 cu. yd of material was required to reclaim the area. Roads, 40 ft wide, have been constructed to serve the transit sheds and other works and an open stacking area, 1,200 ft long by 200 ft wide, has been provided behind the transit sheds.

A bulk sugar installation has been built. This consists of a store, 562½ ft long by 150 ft wide at the base, for the storage of 80,000 tons of sugar. Sugar is brought to the store from the numerous Island factories in containers on lorries and tipped into a hopper feeding on to a conveyor belt passing under the store. The sugar can be fed either into store or direct to an export vessel where it is loaded by means of three fixed towers on the breakwater. Sugar passing to export vessels goes through a weigher tower equipped with a Servo-Balans capable of recording the total weight passing to an accuracy of 0·1 per cent. Each outloading tower can handle 500 tons of sugar per hour. The mechanical handling equipment was fabricated and installed by Spencer (Melksham) Limited as subcontractors to Costain and the electrical installation on the harbour site was carried out by Barlow and Young, also as subcontractors, to a specification prepared by Preece, Cardew and Rider, electrical consulting engineers, of London.

Consulting Engineers: Coode and Partners, 2 Victoria Street, London SW1.
Contractors: Richard Costain Limited, 111 Westminster Bridge Road, London SE1.



Extensions to Toronto Subway



In October, 1959, Robert McAlpine Limited were awarded the contract for the twin tunnel section of the extension to the Toronto Subway. These are the first tunnels in Canada to be driven with shields under compressed air conditions, all other sections of the subway having been constructed by open cut methods.

The tunnel section of the subway consisted of approximately one mile of twin tunnels and includes Queen's Park Station and St. Patrick's Station.

The strata through which the tunnels are being driven are of glacial origin and vary from hard stratified clay to glacial till to a water-bearing sand with water under an artesian head. The compressed air pressures required varied from 10 lb to 20 lb per sq. in depending on the actual conditions encountered, the amount of sand in the tunnel faces varying from 0 to 90 per cent.

The normal running tunnels are being constructed with 16 ft 0 in internal diameter cast iron rings, 2 ft wide, and with flanges 6 in deep. The outside diameter of the tunnel shield is 17 ft 6 in, leaving a 3 in annular space around the tunnel rings to be filled with cement grout. Both the radial and circumferential joints of the cast iron rings are machined. " Philplug " cold caulking compound was used throughout for making all the joints. Cast iron tunnel rings with a $\frac{3}{4}$ in taper were used to obtain the curves in both the horizontal and vertical directions.

The tunnels for the lengths of Queen's Park Station and St. Patrick's Station are twin 24 ft internal diameter cast iron rings.

Before the station tunnels are driven, the 16 ft diameter running tunnels were driven as pilot tunnels to explore the strata. In each station, between the two 24 ft tunnels, 18 ft internal diameter tunnels for escalators and other purposes are being constructed by hand, the escalator tunnels being inclined at 30° up to the station mezzanine areas.

The weights of the two shields are approximately 75 tons and 130 tons. The smaller 16 ft shields are provided with twenty 110 ton jacks and the 24 ft shield with thirty 110 ton jacks. The maximum working pressure provided is 6,000 lb per sq. in, with a normal working pressure of 3,000 lb per sq. in. An unusual feature of the jacks is that they incorporate stationary piston rods and moving cylinders, which is contrary to the normal practice. This arrangement enables the piston rods, which are in contact with the hydraulic fluid, to be completely protected at all times from mechanical damage and contamination by dirt. A hydraulic erector arm at the rear of the shield places the cast iron segments.

Another interesting feature of these shields is that they incorporate all the hydraulic equipment within the shield making it an entirely self-contained unit relying only on the supply of electric power.

The photograph shows the 24 ft diameter tunnel for St. Patrick's Station under construction. This photograph is looking at the back of the shield and shows the working openings in the diaphragm of the shield. In the left foreground is the conveyor for filling the excavated material into the $1\frac{1}{2}$ cu. yd skips, which are removed through the air lock by 3 ton electric locomotives. To the right is the air operated grouting machine. All the cast iron rings are being fixed to a tolerance of 1 in.

Work on these tunnels commenced in December 1959, and will be completed by January 1962.

Contractors: Sir Robert McAlpine and Sons Limited, 80 Park Lane, London W1.

Atomic Energy Centre, East Pakistan

The Pakistan Atomic Energy Commission is to build an atomic energy centre in Dacca, to serve the needs of East Pakistan.

The centre, which will be situated within the campus of Dacca University, will have three main functions. It will provide a centre for training Pakistani engineers, scientists and technicians in the handling and use of radioisotopes; it will incorporate a linear accelerator for studies of high energy physics; and there will be an institute for agricultural research.

The isotope training centre will provide courses of about three months duration for groups of about 25 students per course. The syllabus will include lectures and practical work in nuclear chemistry, nuclear physics, radiation chemistry, radiobiology and electronics, with subsidiary instruction in health physics, procedures, etc. Irradiation facilities will be provided in the form of a 250-curie cobalt-60 source, and a small neutron source for special experiments. Instruction will also be given in gamma radiography techniques. It is not intended at this stage to have a reactor.

The linear accelerator will provide opportunities for the study of advanced physics, and fundamental research work involving high energy particles. The agricultural institute will be primarily concerned with botanical research and will include departments for plant physiology, plant genetics, soil chemistry and entomology. Ample space will be provided for pot culture, and it is intended to erect greenhouses with an associated cobalt-60 irradiation source.

The atomic energy centre will have a comprehensive library, with a smaller departmental library for the agricultural research institute. The centre will also include an auditorium planned to accommodate about 350 people.

The consulting engineers will also carry out the detailed design of the engineering services for the centre and supervise their installation on behalf of the Pakistan Atomic Energy Commission.

Construction is scheduled to begin in October 1961, following the monsoon season, and is expected to be complete early in 1963. The architects for the project are Tajuddin Bhamani and Company, of Karachi.

Consulting Engineers: W. S. Atkins and Partners, 158 Victoria Street, London SW1.

Diesel Power Station for Ghana

The illustration shows an interior view of the engine room of a 30 MW diesel power station being built at the Port of Tema, Ghana.

The nature and treatment of the structural steel frame and the cladding of an industrial building in a tropical climate were two of the important points to be considered in the design. Much has recently been written on the protective treatment of steelwork in such conditions and a wide variety of surface treatments can be specified. At Tema, to reduce maintenance, the use of broad flange beams and welding has been adopted and, to facilitate erection, the site joints are made with high-strength friction-grip bolts.

The steelwork was grit blasted in the works and painted with a high quality primer before dispatch. At site, after washing down with fresh water, it was reprimed and given three coats of micaceous iron ore paint. It has been recorded that paint failures on this type of structure very often occur on the edges of steel members where the paint film tends to thin on application. To combat this defect, an additional coat has been applied to all edges.

The roof is constructed of aluminium sheets which, though an excellent material from the point of view of heat reflection, corrosion resistance and ease of handling, can suffer deterioration from condensation of moisture in lapped joints and by electrolytic action if allowed to come in contact with steelwork. In this case, the problem of the lapped joints has been minimized by the use of sheets of 58 ft length, i.e. the full span, and all the top surfaces of the purlins and steel members in proximity to the aluminium have been covered with a strip of Sylglas set on Densochrome paste.

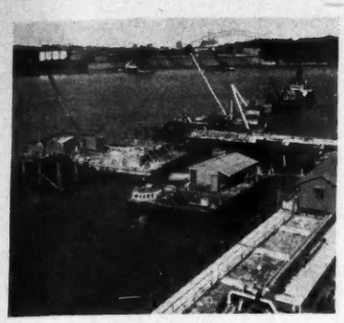
The walls, where not in concrete blockwork, will consist of unreinforced precast concrete slabs giving simple erection and good weathering and insulation characteristics.

Consulting Engineers: Posford, Pavry and Partners, Abbey House, Victoria Street, London SW1.

Supertanker Berth Sydney, Australia

Designed for the Shell Company of Australia Limited by Sir William Halcrow and Partners, the supertanker berth at Gore Bay, Sydney, provides initially for 47,000 deadweight ton supertankers and for future use by 65,000 ton vessels after additional dredging. These large supertankers will discharge crude oil which will be pumped to the Clyde refinery 16 miles away.

Gore Bay is a narrow inlet within Sydney Harbour, partly surrounded by cliffs; space is



extremely limited both for construction work and for manoeuvring large vessels. Steeply shelving rock overlain by sand and silt, made it possible to site the berth only 160 ft from the shore line, without having to dredge into rock.

Ships will berth against two massive breasting dolphins on each side of a jetty head supporting a hose-handling structure. Four mooring dolphins are provided.

The design of the structures was dominated by the fact that piles cannot be driven far enough into the underlying sandstone to develop tension, but high values of compression are obtainable. The 50 ft high breasting dolphins consist of 28 ft by 35 ft boxes of steel sheet piling toed into the rock, cleaned out, filled with stone, and grouted with colloidal cement grout. Power station fly ash was incorporated in the grout to improve its free flowing properties.

The berthing face is cushioned by three layers of Goodyear rubber fendering designed to absorb the energy of ships approaching at speeds up to 9 in per sec.

The hose handling jetty consists of a single thick slab of reinforced concrete encasing the heads of vertical and raking box piles and access is by a reinforced concrete beam and slab deck supported on vertical piles.

No. 1 mooring dolphin is in 40 ft of water and consists of vertical and raking piles supporting a 650 ton block of concrete which ensures that all piles remain in compression under mooring pulls. Mooring dolphins Nos. 2 and 3 are simple mass concrete blocks founded on rock near the shore line. The fourth dolphin is of unusual design because it is located where the steep underwater face of rock approaches very close to an existing sea wall carrying a road and pipe run. Constructed in mass concrete, it is tied back under the road to concrete anchors dug into rock.

Consulting Engineers: Sir William Halcrow and Partners, Alliance House, London SW1.

Tapakuma Scheme in British Guiana

The major part of the population of British Guiana lives on a long narrow coastal strip of land, much of it below high tide level. This, taken in conjunction with an annual rainfall of the order of 90 in per annum, results in an environment of great physical difficulty. The farmlands have to be protected, on the one side from the sea, and on the other from flood waters coming from the hinterland. This is in addition to the drainage of the rain actually falling on the lands themselves. These problems are overcome by empoldering the area and draining it by a massive system of drains for storage and discharge at suitable states of tide. Construction work began in April this year and the first part of the work is to be handed over after 24 months.

Most of the land produces rice paddy and the rainfall is not entirely seasonable or adequate so that irrigation is necessary to ensure the maturing of the crops. Fresh water is usually stored in extensive shallow marshy conservancies behind the frontlands or pumped from rivers in the interior.

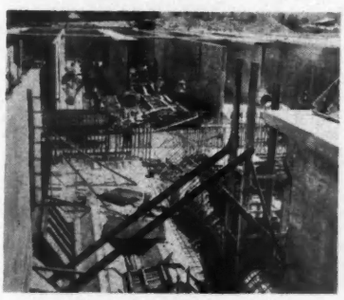
The Tapakuma scheme, which includes the rehabilitation, drainage, and irrigation of some 30,000 acres of fertile land, is the latest of a series of major reclamation and irrigation schemes in British Guiana. Here the main problem has been the ensuring of adequate supplies of irrigation water. The solution has been to increase the storage in three inland lakes and to increase their water supply by diverting an additional stream, the Paray, into them, and drawing water *upstream* from a major river complex, the Pomeroon-Aripiarco. This is possible because of the flatness of the country and the water will be pumped over a river dam into the reclaimed lake concervancies.

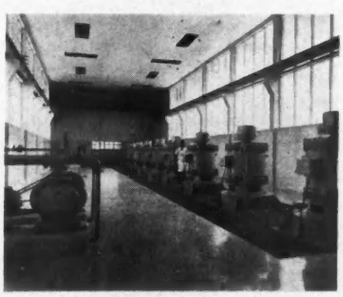
Consulting Engineers: Sir William Halcrow and Partners, Alliance House, London SW1.
Contractors: Pauling and Company (Contractors) (Overseas) Limited, 26 Victoria Street, London SW1.

Sewage Purification Singapore

A number of engineering problems have arisen in consequence of the rapid post-war growth of population in the small island city of Singapore (938,000 in 1947 to 1,479,000 in 1960).

It was quickly appreciated that considerable extension of the sewage treatment works would be required, and J. D. and D. M. Watson,





MM.I.C.E., consulting engineers, have been responsible for two successive extensions of the Kim Chuan Road works which serve the eastern area of the city and with a new works north of the city at Ulu Pandan.

The scheme is designed to serve an initial population of 400,000, with provision for extension to an ultimate figure of 600,000. The total cost will exceed £4 million.

Sewage will be pumped some 11,500 ft through triple steel rising mains to the head of a 6 ft diameter sewer delivering to the new works. Spiral flow grit channels and comminuters are provided at the pumping station which will deal with a maximum flow of 81 million gallons per day.

The treatment works use the diffused air activated sludge process. The works effluent will discharge through an 8,000 ft long culvert to a tidal inlet; to avoid damage to the important prawn fishing industry, the works are designed to give full treatment (to " Royal Commission " standards) to all the sewage reaching it.

Sludge treatment will be by two-stage digestion and open-air drying beds; provision is made for heat sterilization of the sludge so that it can be used safely in agriculture. Sludge gas will be used in four dual-fuel engine generating sets, each of 2,250 kW capacity, which will provide all the power requirements in the works.

The works are due to be commissioned in May this year. The principal difficulties in construction have arisen from the subsoil conditions. Peat and alluvial soils of very low bearing capacity occur in all the low and level areas in this part of the island, and extensive use has been made of bakau piling in constructing the sewer and effluent culvert. The works site was prepared by cutting off the tops of low hills of decomposed shale, and filling the adjacent valleys; some 1,300,000 cu. yd of material were moved.

The construction of the pipelines, pumping station and works have demonstrated the ability of the local contractors to overcome constructional difficulties and produce work of high quality.

Consulting Engineers: J. D. and D. M. Watson, 67 Tufton Street, London SW1.

Iron and Steel Works Durgapur, India

Durgapur, in West Bengal, was a project for an integrated iron and steel works carried out by a consortium of 13 British manufacturing and contracting companies. The contract, worth approximately £105 million, to construct the steelworks for completion in four stages, was awarded in 1956. W. S. Atkins and Partners were retained by Davy & United Engineering Company and Wellman Smith Owen Engineering Corporation as consultants for all the civil engineering and building work within their contracts. Davy & United Engineering were responsible for the work within the perimeter of the rolling mills, central engineering shops, foundry and wheel and axle plant. Wellman Smith Owen Engineeering were responsible for the steelmaking plant.

The consulting engineers were responsible for the designing and preparation of working drawings for the civil engineering work, together with ancillary buildings within these areas, and also the design of the cooling water system. The work here embraced a pumphouse and substation, two 100 ft diameter Dorr clarriflocculators, a filter house, an elevated 20 ft diameter tank, together with the sizing and routing of cooling water mains. The system was designed for a production of 1 million ingot tons a year, with provision for duplication in the future to achieve an ultimate output of 2½ million ingot tons a year.

The initial project is to be handed over in running order by the late autumn of 1961. There are three batteries of coke ovens, three blast furnaces of 27 ft hearth diameter, seven 200 ton open hearth furnaces for ordinary steels and one 100 ton furnace for the special steels for the railway wheel and axle plant. The rolling mills comprise a 42 in blooming mill, a 32 in breakdown mill, a billet mill, a structural mill and a bar rod mill.

All civil engineering design was carried out in the United Kingdom and, at the peak period in the autumn of 1958, 90 senior engineers and draughtsmen were engaged on the work.

Consulting Engineers: W. S. Atkins and Partners, 158 Victoria Street, London SW1.

Proposed Road Bridge over the Kaduna River in Nigeria

Traffic using the main route connecting Lagos, the Federal capital of Nigeria, through Jebba and Mokwa with Bida in the Northern Province, at present crosses the Kaduna River at Wuya, a small village some ten miles to the west of Bida, by means of a pontoon ferry operating over a width of about 1,000 ft.

The Kaduna River, which joins the Niger River some 25 miles downstream from Wuya, drains a catchment of approximately 25,500 square miles and, in the past, there has been extensive flooding of the ferry area. A permanent bridge and new approaches are therefore to be built.

The Kaduna River for some distance both upstream and downstream from the proposed site of the bridge is confined within a flood plain about 2¼ miles in width. It meanders between non-vegetated sandbanks, which are usually exposed at low water levels and liable to fluctuate in position during each wet season, and more stabilized vegetated sandbanks not normally inundated except during flood periods.

The site selected for the new bridge is adjacent to that of the present ferry crossing and data obtained from a series of borings sunk in the area indicate that the sub-strata consists of fairly recent alluvial deposits of sand and gravel overlying beds of older and harder sediments which, as the topography of the surrounding landscape suggests, have undoubtedly been subjected in the past to a greater overburden pressure than at present exists. Bedrock was not encountered in any of the borings.

A preliminary report on the project has already been submitted and from the results of the studies so far made it would appear that, for the safe passage of the maximum discharge likely to occur in the channel at Wuya, a bridge giving a clear water way of some 1,650 ft will be required.

The type of bridge crossing likely to be most suitable is not influenced by navigation conditions nor by a specified minimum clearance above predicted maximum water level and, with site conditions as they are, preference is likely to be given to a multi-span structure with masonry piers and superstructure in either steel or prestressed concrete.

The whole project includes, in addition to the bridge structure, the construction of elevated road approaches and ramps and, for the purpose of protecting the bridge site and stabilizing the channel conditions, the provision of river training works in the form of spurs or guide banks;

to assist the designs model experimental work is now in hand at the Hydraulics Research Station, Wallingford.

The scheme, for which the preparation of designs and contract documents will shortly be taken in hand, is being carried out under the jurisdiction of the Ministry of Works, Northern Region of Nigeria, Kaduna.

Consulting Engineers: Scott and Wilson, Kirkpatrick and Partners, of Apapa, Lagos, and 47 Victoria Street, London SW1.

Krian Irrigation Scheme in Malaya

The Drainage and Irrigation Department of Malaya have decided to increase the capacity of the Bukit Merah reservoir by raising its level by 5 ft. At present there are two separate spillways to discharge flood water and an intake structure which feeds canals for irrigation purposes. It is proposed to discard one of the flood discharge spillways altogether and construct a new one under cover of the other existing barrage to deal with the whole of an estimated maximum flood discharge of 10,000 cusecs. At the same time, the existing intake structure is to be replaced by a new one in a place more suited to the changed conditions.

Sir William Halcrow and Partners have been asked, through the Crown Agents for Oversea Governments and Administrations, to prepare designs, working drawings and specifications for the proposed works, which will be constructed under the direction of the Director of Drainage and Irrigation in Malaya.

The new flood discharge barrage will consist of six radial gates, 21 ft 8 in long and 7 ft 3 in high, sealing on to the crest of a new concrete weir whose crest is 7 ft 9 in above bed level. The gates will be operated automatically in sequence by the reservoir level opening as the water in the reservoir rises above normal retention level. In addition, a seventh radial gate, also automatically operated, of the same length as the others but only 2 ft 6 in high, will be installed at the centre of the barrage. The purpose of this gate, which would open first in the sequence, is to enable large masses of weed to be released from the reservoir with minimum loss of water and to obtain a finer control for minor floods.

The spillway bucket design has been developed with the aid of a model and the gate operation is also to be checked by model tests. Both the gates and counter balances are to be made of mild steel protected by a zinc sprayed coating and paint.

The new intake is a conventional concrete structure with six standard hand-operated sluices, each 6 ft wide by 7 ft high.

Consulting Engineers: Sir William Halcrow Alliance House, Caxton Street, London SW1.

Abattoir and Flying Fish Plant for Barbados

The Government of Barbados have approved plans for a new combined abattoir and cold storage plant for flying fish to be built at Bridgetown. It will enable the Barbados Government to consider marketing flying fish in consumer packs, with possible export to other of the islands, thereby strengthening the Barbadian economy.

Though housed in the same building, the abattoir and the flying fish plant will operate completely independently. The abattoir is designed to handle 15 to 16 tons of dressed pigs, sheep and cattle per week, the tripes and offal being processed in an associated by-products plant for conversion to fertilizer or for disposal.

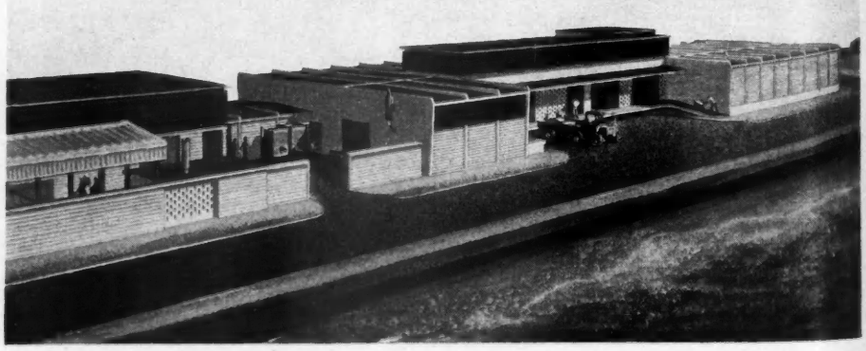
The flying fish plant incorporates fish icing and freezing equipment with a total cold-storage capacity of 260 tons. The quiet freezing plant is capable of freezing at the rate of 1 ton of fish in two hours. Once the plant has been established, consideration will also be given to the provision of mechanical fish filleting equipment but initially a pilot plant, employing hand filetting, will be operated to establish the market potential. A retail shop, in addition to wholesale trade facilities, is to be provided as part of the cold storage plant.

The building, shown in the illustration, which houses this joint scheme is to be built with a reinforced concrete framing, roof and floor slabs, with hollow block walls. All the roof beams over cold store and process areas have been kept above the roof slab to give a smooth soffit to the ceilings to facilitate the distribution of cold air for ease of cleaning. Within areas refrigerated below freezing point the floor slabs are raised to loading platform level, which will not only facilitate the handling of the fish but also permit the free passage of air beneath the building, thereby obviating the risk of frost heave and damage.

The scheme also includes the construction of a landing jetty for the fishing boats serving the freezing plant. It will provide berths for about eight boats up to 24 ft long with a draught of 5 ft.

The project will be built by the Public Works Department under the control of the director, Mr. I. D. Imbert. All plant and equipment to be supplied will be ordered by the Crown Agents on behalf of the Barbados Government. Work on the project is due to start this summer.

Consulting Engineers: Brian Colquhoun and Partners, 18 Upper Grosvenor Street, London W1.



Companies

Hoover Apprentices in Commonwealth Week

THOUSANDS of United Kingdom firms and more overseas are joining in the ceremonies and exhibitions of the Commonwealth Technical Training Week, and the simplest way to show what the week means to the employees of many engineering companies is perhaps to examine one in detail.

HOOVER are a useful example in that with a substantial part of their production going overseas they have factories in England, Wales and Scotland and are closely identified with the Technical Training Week. From the Perivale, Middlesex, training department, two apprentices will attend the St. Paul's Cathedral service on 1 June at which the Duke of Edinburgh is to be present. Examples of the work done by Hoover apprentices and of opportunities for young people with the company are being displayed at Ealing Town Hall in West London. Tours of the factory have been organized for school children.

In Wales, the Hoover plant is at Merthyr Tydfil, Glamorgan. Mr. John G. Davies, chairman of the Apprentices' Association, is to attend the Duke of Edinburgh's lunch in Cardiff on 2 June. On the same day eight craft apprentices will take part in a parade through the Cardiff streets. A Hoover exhibition on craft training is being mounted in the Merthyr Tydfil College of further education. The education and training officer will take part in training discussions with the local authorities.

At Cambuslang, Lanarkshire, in Scotland, the Commonwealth Technical Training Week begins on 28 May with the flags of the Commonwealth being run up at the factory to the strains of the pipes—played by an apprentice. Graduate, student and craft apprentice activities and the training of young people generally are all included in a special display at the company's training school.

More Capacity Less Profit

Years of steadily building up the capacity of C. A. PARSONS and Company, of Newcastle upon Tyne, have brought the company to the considerably increased turnover of last year which gave a trading profit of £4,756,143 (against £3,189,245 in 1959) and a net profit of £2,563,708 (1959—£2,088,786).

With turbo-generators getting larger and larger the number of orders is in decline, leading to a perhaps serious ebb and flow of work in the big manufacturing concerns. The level of orders taken for turbo-generators in 1960 was low, as it had been in the earlier year. Some parts of the factory are working below their maximum capacity and by the end of this year others will be affected. The placing of a substantial order by the CENTRAL ELECTRICITY GENERATING BOARD, which will make orders for 1961 better than for some time, will not change this situation.

Work is in progress on improving the facilities for testing transformers of large sizes and high voltages and transformer orders are at a satisfactory level.

Mr. H. H. Mullens, the Parsons chairman, detects that the tendency for heavy industrial manufacturing capacity to go on increasing is now matched by reduced profit margins. Since there is a world wide excess of manufacturing capacity for turbo-generators and transformers reduced profit margins in orders taken against foreign competition are as good as certain.

The company's nuclear research centre, in operation for only two years, has attracted a "gratifying" volume of extra-mural contracts from the United Kingdom and overseas. Its facilities in metallurgy, physics and computational services are outstanding. These laboratories are tending to be used increasingly in connection with Parsons conventional non-nuclear work.

Joint research arrangements with ASSOCIATED ELECTRICAL INDUSTRIES and with REYROLLE are working out satisfactorily. A more recent step has been the CEGB's proposal that the Board and the larger power plant manufacturers in Britain should collaborate in research.

Advanced TV Lens for Moscow Trade Fair

The only television zoom lens of its kind in the world with a focal range of 4 in to 40 in is being shown at the Moscow Trade Fair by the TAYLOR, TAYLOR AND HOBSON division of RANK PRECISION INDUSTRIES Limited.

Enabling the camera operators to go from long shots to close ups without pausing for lens adjustments, the zoom lens is produced by precision tools and manufacturing techniques which Taylor, Taylor and Hobson have spent 18 years in developing.

The magnified eye in the picture is that of a technician at the company's Leicester works. He is scrutinising a part of the mechanism of the Varotal 3 lens before the next phase of the operation. The lens is 27 in long, and weighs 33 lb. Aspherical glass components are an essential part of the design, which incorporates thirteen glass elements.

Compelled by their own needs to pioneer in metrology techniques, the Talyrond and Talysurf instruments produced by the company have been accepted as setting international standards in the measurement of roundness and surface roughness.

The instruments being shown in Moscow demonstrate a range of instruments for the measurement of surface finish, squareness, parallelism, straightness, the accuracy of plane surfaces and deviations from the horizontal and vertical.

Rank Precision have high hopes of the outcome of their sales efforts in the USSR. Not without reason, for in 1960 the instruments sold in Russia by the company were worth £100,000.

Stainless Steel's Bright Profit Record

For the ENGLISH STEEL CORPORATION, which is 75 per cent VICKERS owned and 25 per cent CAMMELL LAIRD, production is being maintained so far this year, and the prospect is that this will continue. There is some concern in the company at the effect on competitiveness of the increases in the costs of coal, electricity, gas and transport and in addition, at the changes to be brought about by the Rating Bill. A great effort is being made to overcome the adverse effect these influences may have on the position of the heavy engineering industry in relation to its competitors.

The 1960 results from English Steel show that on a greater volume of sales the trading profit rose from £4·32 million to £4·67 million. The outstanding event of the year was the beginning of the work on the £26 million development scheme at Tinsley. When in full production, this new capacity for special carbon alloy and stainless steel will bring the annual output of these products up to 850,000 tons.

Most parts of the group were busy throughout the year, ending with a larger volume of orders in hand than they had started the year. A measure of the increased activity was the rise in steel melted from 464,200 tons in 1959 to 572,000 tons in 1960. This was still not quite up to the peak of 1956 when 591,000 tons were melted. Direct exports accounted for 12½ per cent of last year's turnover and there was, of course, a high proportion of special steel sold to exporting manufacturers.

Overtime working at the rolling mills was necessary to meet the demand from all the engineering industries for alloy and special carbon steels in billet and bar form. Stock reduction and a tendency to restrict orders which began in the later months of the year has brought about a reduction of output to more usual levels in the early part of this year. A strong demand from home and overseas markets has kept up well for high speed and tool steels.

Labour Limitation

In the ENGLISH STEEL FORGE AND ENGINEERING CORPORATION, one of the operating companies, a modest demand for heavy forgings made it possible for the 8,000 tons press unit to be reconstructed without causing inconvenience to customers. Shortage of skilled labour limited output to some extent in meeting the increased demand for medium type press forgings.

At the operating company responsible for castings, the steel foundry was fully occupied and reached a record output. Continuing demand for heavy steel castings for capital developments in the steel and engineering industries, in addition to the wider acceptance of the specially designed castings for railway rolling stock, is thought likely to ensure full production in the current year.

With closely linked interests, TAYLOR BROTHERS, of Manchester, another of the operating companies, were producing wheels and axles very much below their full capacity as a result of the scarcity of orders for new railway rolling stock in the world market. This applies to the overseas subsidiaries too. CANADIAN STEEL WHEEL Limited has a new plant which is operating at a rate below the intended level of production. This company is jointly owned by English Steel and A. V. ROE CANADA Limited. In South Africa the wholly-owned subsidiary STEEL WHEEL AND AXLE Pty is similarly handicapped.

Altogether more cheerful results came from FIRTH-VICKERS STAINLESS STEELS, who are jointly owned with THOMAS FIRTH AND JOHN BROWN. Firth Vickers had more home and overseas orders than they could meet and are coping with an expanding use of stainless steel over a widening range of industries.

Sheffield Development

The additional plant authorized to meet this situation is expected to be in production early next year. Profit for the year, before tax, of Firth-Vickers Stainless Steels increased from £1,175,228 in 1959 to £2,537,685 during last year.

Appropriate approval has been secured for the £26 million Tinsley Park, Sheffield, scheme and site preparation began last November. Including the working capital, a total of £30 million will be needed for the scheme and arrangements have been made for short and medium term funds amounting to £20 million. It is expected that this will be repaid out of retained earnings. Longer term capital, which with other financial needs, is expected to be £15 million, is to be raised partly by issuing further debenture stock and in part from the parent companies. Commitments have been agreed for a 42 in primary mill, two 32 in cogging mills, a train of bar rolling mills and the primary electrical plant. Contracts have been placed for the principal buildings, for two 100 ton electric melting furnaces and for soaking pits for ingot heating prior to rolling.

Canadian Uses of Nickel Cast Iron

Inco's activities in Manitoba have given forceful assurance of nickel supplies. Canadian engineering has itself pioneered uses of one nickel product—Ni-Hard cast iron.

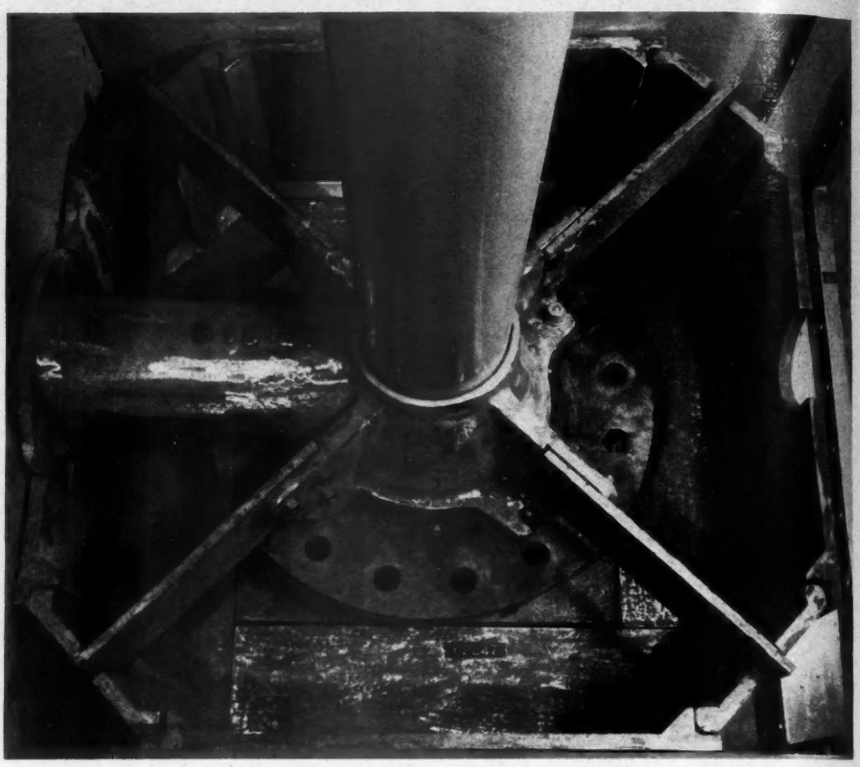
ADDRESSING the shareholders of the International Nickel Company of Canada on 19 April, Mr. Henry S. Wingate, chairman and chief officer, spoke of the great impact that his company's operations at Manitoba would have on world supplies of nickel. "In a matter of weeks," he said, "I expect the plant to be turning out nickel at a rate of more than 75 million pounds a year.

"Thompson is the second largest producer of nickel in the world. Only our own Sudbury District operations here in Ontario are larger.... In 1960, we delivered a record of nearly 352 million pounds of nickel, including over 51 million pounds of purchased nickel. These and the similar further acquisitions continuing in 1961 lessen the United States Government's accumulations of surplus nickel and, at the same time, help us to build a strong stock position, which provides additional assurance to nickel users of the reliability of nickel supplies.

"The Thompson project has special meaning also to our activities abroad, particularly in the United States and Europe, since Canada's nickel requirements represented, even before our new project came into being, only a small fraction of Canada's production."

So with the Thompson project on stream, the world can look with some assurance to developing uses of nickel. Although consuming only a small part of her output, Canada herself is very alive to making good use of the metal. One of the outstanding contributions which Canadian engineering has made to our knowledge of materials, is the pioneering use of cast iron containing between four and five per cent nickel —in other words, of Ni-Hard. On this page are two examples where this tough and abrasion resistant cast iron has been put to work; they are examples of engineering in which Canada would be expected to lead—in mineral processing, and in sea and inland waterway control.

From a technical standpoint it is important not to confuse this basically white cast iron which is very hard, brittle and virtually unmachinable, with the other high strength but ductile iron containing spheroidal graphite. Ni-Hard is used primarily for its abrasion resistance, SG iron for its high strength and ductility.



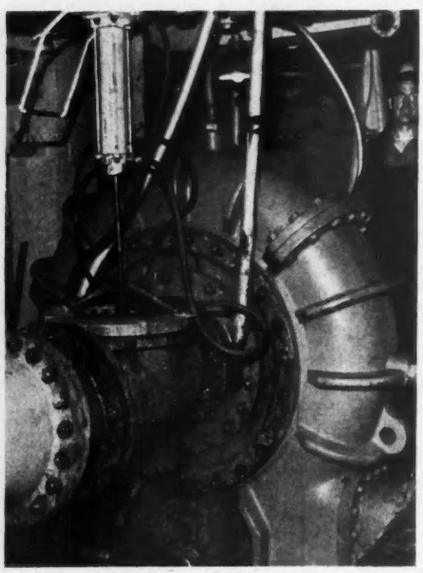
for Liner and Weir in Flotation Machines

Several flotation machines used in the Sudbury District of Ontario by Inco to extract valuable sulphide minerals from 40 per cent solids ore pulp are made by Denver Equipment Company. The illustration above shows the lower parts of a cell in one of these flotation machines, which incorporates several Ni-Hard castings.

The Denver flotation cell components, with the exception of the impeller, diffuser and bottom liner, were originally made of white iron; the impeller and diffuser were rubber covered and so was the bottom liner.

Ni-Hard was first tried as a replacement for white cast iron on the stationary hood and was shown to outwear it by five times. Thus, for recently installed cells (based on this finding), Ni-Hard was specified for the bottom liner, hood, hood wings, side liners, corner liners, partition plate half sections and the weir.

The weight of the Ni-Hard castings involved in each cell is 2300 lb; the Ni-Hard weir weighs 480 lb. These nickel iron castings were made by Wabi Iron Works at New Liskeard, and at the time of publication last summer in *Inco Nickel News* it was reported that 45 tons of Ni-Hard had been used in such cells.



for Liners in Dredging Pump

Inside the pump casing shown here is an all-Ni-Hard lining. This material has replaced high alloy steel liners which often used to wear out in five days of operations. Life is reported to have been increased 5 to 10 times.

This centrifugal pump is one of two suction pumps on dredgers operated by British Columbia Bridge and Dredging Company. The larger dredger, the "W. G. Mackenzie," operates with a sand pump having 32 in suction and 27 in discharge with an 84 in impeller. This pump was operating last year with Ni-Hard liners on both front and back doors and in the suction throat.

On the smaller "Western Dredger" the sand pump has 18 in suction and 16 in discharge. Last year is was equipped with a pump that was fully lined with Ni-Hard castings and also a Ni-Hard impeller. The operators claimed it gave better results with less trouble than any previous pump ever used on the West Coast of Canada. Three-quarters of the previous liner changes were said to have been eliminated. It is this pump which is illustrated here. The liner was cast and machined at Letson and Burpee Limited in Vancouver, British Columbia.

Inexpensive Pvc Bellows

This illustration shows the manufacture of a large dip moulding by dipping a heated mandrel into pvc paste. This method was the subject of an article in this journal (ENGNG., 28 Oct. '60, p. 566) and readers will have noted that the advantage offered by the process is the extreme cheapness—often resulting in a final cost less than half that of an equivalent rubber article.

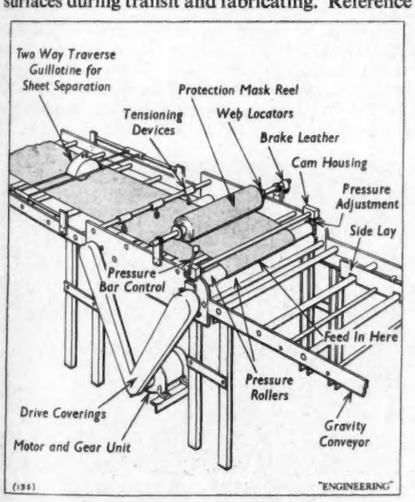
Plastic Coatings say that this bellows was made recently for Ames Crosta Mills and Company. The coupling is part of a variable level control on a sewage effluent plant and is made from a grade of pvc which has flexibility at −30° C. Plastic Coatings are also making similar couplings for joining together the pipework used in fume recovery systems.

Ames Crosta Mills and Company Limited, Heywood, Lancs.

Plastic Coatings Limited, By-Pass, Guildford, Surrey.

Applicator for Protection Tapes

In the 12 May '61 issue of this journal (pp. 666-67) there was an article which presented user comments on a wide self-adhesive paper tape product which Gordon and Gotch have recently launched. This is used for protecting polished metal surfaces during transit and fabricating. Reference



was made to an applicator which can be supplied to apply these tapes.

Here is the maker's description. The machine, which is 3 ft 6 in overall in length and has a working height of just over 3 ft, will press the protection mask on to a smooth surface cleanly and without creasing—a great asset during large scale application. It has a variable speed power drive, gives application speeds between 5 and 50 linear feet per minute and can be easily operated by unskilled labour. An automatic stop device ensures no wastage of material once the surface to be protected has been covered.

Additional units to the machine are a 3 ft roller conveyor section at the head for ease of feeding and, at the rear, a 5 ft conveyor takeaway section with a two way traverse guillotine attachment for cutting off the protection mask at the end of each protected sheet.

The Sello-Shield applicator will take widths of protection mask up to 24 in wide or, if specially required, up to 48 in wide. The rollers of the machine can be adjusted to admit materials up to 1 in thick.

Gordon and Gotch (Sellotape) Limited, 8-10 Paul Street, London EC2.

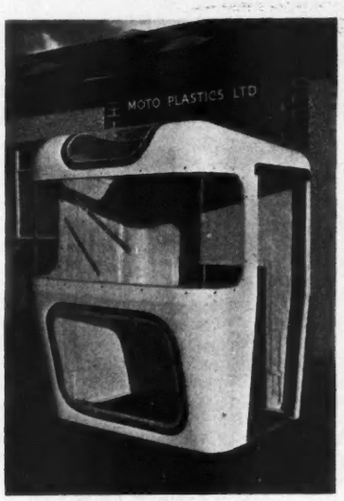
Plastic Sandwich for Crane Cab

Moto Plastics have used a sandwich structure in making a crane cab. This consists of two skins of glass reinforced polyester with a firmly bonded core of expanded pvc (Plasticell made by Microcell Limited).

Moto comment that this type of sandwich construction—which is rather similar to a honeycomb panel in concept—is particularly suitable for very large mouldings where great strength and low weight are essential. It is also said to give excellent sound and thermal insulation.

The cranes for which this cab is made are seagoing—for use on cargo ships—and they therefore have to withstand rough seas and very varied climatic conditions. With this continuous construction and the right grade of polyester, the corrosion resistance can be made very good.

The cab is a one piece moulding, produced in a female mould which is sectioned and dismantled to release the cab moulding. After applying a thin pigmented coating of marine grade polyester to the mould, the outer skin is laid up to a thickness of $\frac{1}{16}$ in with glass reinforced polyester.



To the back of this outer skin is laid a $\frac{1}{2}$ in thick layer of expanded pvc in the form of 12 in square tiles. Finally, the back surface is applied which is again $\frac{1}{16}$ in of glass reinforced polyester.

The final sandwich has a glossy white outer surface. The inner layer is pigmented a pastel shade and comes in a matt finish (since it is not up against a shiny mould surface) which is useful because it avoids glare.

The design and structure of the cab give it rigidity without the need for any framework, say Moto Plastics. A metal angle is moulded into the base of the cab, but this is simply for fixing the cab on to the crane platform. Again, there is a metal frame around an aperture in the rear of the cab, but Moto say this is to take the box which houses the electrical control gear.

A further unusual feature of the cab is its Perspex acrylic windows which are also moulded by Moto. They are said to give maximum visibility and are fixed in such a way that they can be removed if necessary. However, they are sealed to prevent any ingress of moisture, even to the extent of plastic screw caps covering the heads of fixing bolts.

This cab stands 6 ft high and is 5 ft wide and 4 ft 3 in from front to back. The roller shutter door is also made in glass reinforced plastic. Moto comment that this cab is much lighter than the equivalent metal one, but they are not quoting figures until a detailed comparison has been prepared.

Moto Plastics Limited, Ponteland, Newcastle upon Tyne.

Terylene/Cotton Conveyor for Quarry

One of the longest above-ground conveyor belts in the country—over 2000 ft long—contains Terylene polyester fibre for reinforcement. This belt is 24 in wide and carries up to 200 tons of sand and gravel an hour at the Midland Gravel Company's quarry, in Sutton Coldfield.

Made by Barrow, Hepburn and Gale, from a 4-ply Terylene/cotton fabric, the rubber

covered belt is not only stronger than the cotton belts previously used but it is also cheaper, say ICI.

When Midland Gravel decided to change over to such conveyors, the whole system was redesigned by Mining Engineering Company to take full advantage of the strength and flexibility of the new style belt. Previously, three belts and two transfer points were necessary. These have now been replaced by one belt, thus saving the wages of two men. Now one man is stationed at each end of the belt and they keep in touch by field telephone.

Imperial Chemical Industries Limited, Millbank, London SW1.

Flexibilizer for Epoxy Resins

Shell Chemical Company have introduced a resin, Epikote X-71, to their range of liquid epoxy resins. Shell say it may be used in combination with the liquid Epikote resins 815, 828 and 834, to increase significantly the flexibility, impact strength and toughness of the cured composition, while at the same time serving as a viscosity modifier.

It is particularly recommended for use in the production of crack-resistant castings and for the encapsulation of electrical components where flexibility and resistance to mechanical and thermal shock are required.

Shell Chemical Company Limited, 170 Piccadilly, London W1.

Plastic Laminating Presses Automated

Productivity increases of up to 30 per cent are reported with a new automatic loading and unloading system for multiple platen laminating presses.

AN AUTOMATED loading and unloading system for large multiple-platen laminating presses has been developed by Pathex (Canada) Limited of Toronto, Canada.

It is believed to be the only system of its kind in the world and six installations are now in operation in Canada and the United States. Large manufacturers of plastic laminates such as Arborite Limited, Continental-Diamond Fibre Limited and Consoweld Corporation, are among those who already have installations. The system also has a wide application in the production of plywood and wood composition laminates and a variety of other non-metallic sheet materials. Considerable increases in production efficiency are reported by companies with installations now operating.

The demand for plastic laminates over the past few years has been very great indeed and manufacturers have often found difficulty in keeping pace with demand. As a result of this, hydraulic presses with working pressures up to 6,000 tons have evolved and multiple-platen presses now produce simultaneously up to 75 sheets of laminate, each 6 ft by 12 ft.

The basic problem with large presses of this nature has been the excessive idling time required for the feeding of materials and removal of the finished product. As presses grow larger, up to 30 per cent of production time may be wasted. Pathex, who have in the past contributed to the design and installation of some of the largest hydraulic presses in the world, anticipated this problem and their automatic loading and unloading system was developed to meet the demand.

The average press cycle time required by plastic laminates is 80 minutes. The preparation of materials and caul plates, the feeding of the plant and the removal of the finished product—during which time the press is idle—can take as much as 30 minutes with manual methods. The new system cuts this idling time down to about 30 seconds.

The basic laminating process requires the preparation of materials such as paper or textiles impregnated with thermosetting resins and assembled between thin steel caul plates and carrier plates. Up to five sheets of laminate may be sandwiched in this manner. These " books," as they are called, must then be placed between the platens of a press and cured under heat and pressure.

The process requires the utmost cleanliness. Any foreign matter such as oil or abrasive particles will ruin the surface of the laminate and interfere with the curing process. The cleaning of the caul plates between each cycle presents a difficult situation. These plates are usually about 5 ft by 12 ft and are very ungainly to handle. The face of the plate which is in contact with the laminate must be maintained absolutely clean and free from scratches.

NEED FOR MECHANIZATION

Since the caul plates are also used for subsequent curing cycles, a sufficient number of extras must be available to allow time for cleaning and material preparation without keeping the press waiting. It can easily be seen that unless these operations are mechanized, a large work area and considerable manual labour would be needed to handle the excessive number of caul plates and carrier plates in process between press cycles.

The ideal situation with, say, a 15 platen press, is to have just two sets of caul plates and carrier plates, one set being in use in the press while the other set is transferred, removed from the finished product, cleaned and inspected, reassembled with further laminate materials and placed in the loading position. For optimum efficiency, this work must be performed during the cycle time of the press—that is,approximately 80 minutes.

With the Pathex system this optimum is achieved so that the press is actually idle for only 30 seconds while the automatic loading and unloading function is performed. Only two men are required per press—the actual press operator works from a remote control room and may control up to five 15-platen press installations of this type.

The system is composed of three basic units and a transfer conveyor line. The first is a caul turning machine which is a self-contained hydraulic handling device with push button operation. The second is a loading unit. This is a multiple layer cage arrangement of short lengths of free-roller conveyor, the whole assembly being raised and lowered by a Saginaw screw system so as to align with the assembly station and the platens of the press. A further Saginaw screw operates a horizontal pusher device which feeds the assembled books into the loading cage and subsequently into the press. The third unit is the unloading unit. It is basically the same as the loading unit except that it has a pulling device to remove cured books. The transfer conveyor line automatically returns cured books to the loading end of the system where they are disassembled.

OPERATING SEQUENCE

The sequence of operations in the system, as illustrated in Fig. 1, is as follows:—

1. The press is closed and the curing cycle commences. At the same time the cured books arrive back at the loading area.

2. Using vacuum suction cups, the caul turning machine disassembles the books. The first caul plate is lifted from a face-down horizontal position and turned to a vertical position, an operation illustrated by the caul plate positions in Fig. 2. The plate is held firmly while the operator cleans and inspects the surface. The caul plate is then returned to the horizontal but is held above the book. The whole machine rolls along a track to the assembly table and the caul plate is placed face down on the prepared laminate materials which have been meanwhile assembled on a carrier plate. The machine then rolls back to the previous position, lifts the first sheet of finished laminate, rolls in the opposite direction and deposits it on a transfer skid. This is repeated until the book is completely disassembled and subsequent books are handled in the same manner.

3. When the first new book of uncured materials is completed, the loading cage is lowered into a pit and elevated step by step. Progressively, the books are inserted in the slots of the cage. When the cage is full, it is automatically aligned with the press platens. At this point, the curing cycle of the previous batch is complete.

4. A rapid sequence now occurs. The 15 press platens are opened simultaneously, the puller device at the unloading end runs through the middle of the cage of platens, jaws grip the edges of the 15 books simultaneously and withdraw them on to the cage. As this occurs, the pusher device is closed and the cycle recommences.

5. Immediately the first cured book is removed from the cage it is returned by the transfer conveyor to the assembly area and the sequence of operations is complete. The remainder of the cured books are progressively removed in a manner the reverse of the loading operation. Each book is pulled from the cage by the puller device as each slot of the cage is automatically aligned with the conveyor. The intermittent power system of the conveyor automatically spaces the cured books the required distance apart as they travel to the dissassembly area.

While there is some saving in labour costs and a reduction in the required manufacturing space, the value of this system is primarily measured in terms of machine productivity. The installations currently in operation have increased productivity up to 30 per cent. On a 15 platen press of the size mentioned in this article, the possible annual increase in production is about 9 million sq. ft of finished laminate.

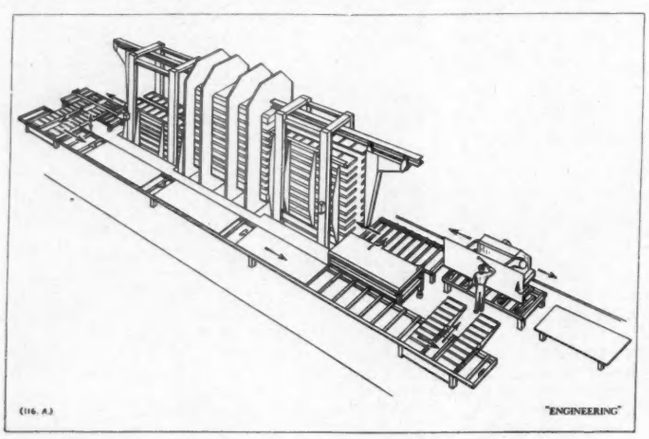


Fig. 1 This simplified diagram shows the basic operational features of the automatic loader-unloader installation.

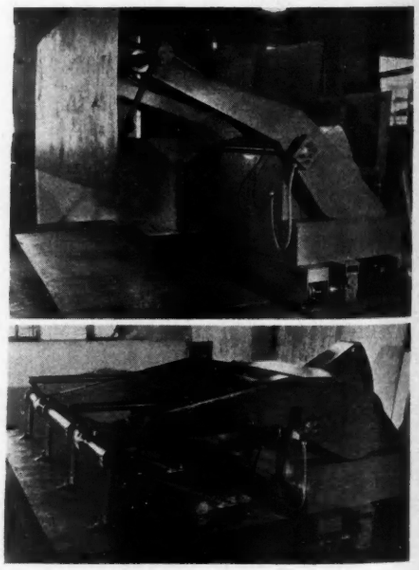


Fig. 2 Composite illustration of the caul turning machine in horizontal and vertical positions.

Indian Machine Tool Prospects

With industrial development, the demand for machine tools has risen steeply in India. By the end of the Third Plan period (1966-67) it is expected that this demand will be in the order of Rs 60 crores (£45 million). At present most of the country's requirements are met by imports but production is increasing at the Hindustan Machine Tools Factory, Bangalore, at the Praga Tools Corporation, Hyderabad, and at privately owned factories. In 1960 domestic production in the public and private sectors, including the small manufacturers, was about Rs. 10 crores.

The Hindustan Machine Tools (HMT) factory, which now produces 1,000 machines valued at about Rs 4 crores, plans to double its annual output by 1965. During its European tour, the HMT delegation signed an agreement with Renault of France for technical collaboration in the manufacture of special-purpose machines, an arrangement which will make it possible for HMT to meet at least half the demand for this type of machine by indigenous production.

Technical collaboration agreements have also been signed recently by the Praga Tools Corporation with Kearney and Trecker CVA Limited, of Hove, Sussex, for drill chucks; with F. Pratt and Company Limited, of Halifax, for lathe chucks, magnetic chucks, and pneumatic chucks and vices; and with A. A. Jones and Shipman, of Leicester, for cutters and tool grinders.

Praga Tools Corporation, a publicly owned corporation, produces machine tools and accessories worth Rs 60 lakhs (£450,000) annually. The Indian Government intends to expand this factory's production to an ultimate figure of more than Rs 2 crores (£1½ million) per annum.

The Government have also decided to set up a publicly owned factory in the Punjab on lines similar to those of the HMT and with a production capacity of 1,000 machine tools annually. The capital cost of this new factory is estimated at Rs 5 to 7 crores and its annual output at Rs 4 cores. An official delegation which the managing director of HMT led to East Germany in March of this year signed an agreement with Limex for technical collaboration on this project. Production at the new factory will include universal milling machines, production millers, die sinking milling machines, gear cutters, hobbers, shapers and grinders, and special purpose machines.

Durgapur Steelworks ahead of Schedule

With the completion of testing of the 100 ton open hearth furnace (the final unit of the melting shop) all the steelmaking facilities at the Durgapur Steelworks, West Bengal, India, have been installed well ahead of schedule. Three furnaces went into production last year; dates for commissioning the others have yet to be fixed.

The steel melting shop consists of seven open hearth furnaces of 200 tons capacity each and a 100 tons capacity furnace specially designed for producing steel for wheel sets for the Indian Railways.

The steelmaking plant is based on the most modern layout and will produce one million tons of ingot steel per year. Now that No. 3 blast furnace is operational, the iron making facilities have also been completed. Like its predecessors, it is rated to produce 1,250 tons of iron per day, an output which has already been frequently exceeded on Nos. 1 and 2 blast furnaces.

All three blast furnaces are fed by a comprehensive coke, iron ore and limestone handling system feeding into bunkers on the furnace high line. Raw materials are carried from the bedding plant by a conveyor system, though provision has also been made for feeding the furnaces by rail-borne raw materials.

This plant was designed and built, as described elsewhere in this issue, by a member of ISCON—the Indian Steelworks Construction Company Limited—the consortium of British companies responsible for the construction of the steelworks. Worth £120 million, Durgapur is claimed to be Britain's largest ever single export order.

Australian Ferrous Forging

The February issue of *Australian Mechanical Engineering* reported that a recent survey of firms in the industry showed that those which have introduced modern equipment and methods have now taken over a major share of the market and have succeeded in keeping costs reasonably stable. Total production of ferrous forgings in the country during 1958-59 was 125,000 tons valued at about £A23 million, and production has remained fairly constant.

Growth of heavy forging increased considerably during the Second World War and was based principally at Newcastle and Port Kembla, in New South Wales, and at Maribyrnong in Victoria. The shortage of supplies and extended overseas delivery times further stimulated the home industry after the war.

A significant new item of plant was introduced to the industry in 1953 with the installation at the Newcastle works of the Commonwealth Steel Company of a 5,100 ton hydraulic press which would be capable of handling an ingot weighing up to 135 tons.

At present 90 per cent of the country's total production comes from the states of New South Wales and Victoria, the forgings produced in Queensland, South Australia, Western Australia and Tasmania being on a limited scale. Post war emphasis has been on production line output of precision forgings, especially for the growing automobile industry, but there has also been a significant demand from the railway workshops of the State Governments.

The techniques and equipment used by the industry and the quality of the end product are claimed to be comparable with overseas standards. However, while research and new production methods have encouraged efficiency in the newer sections of the industry, the equipment and methods of the traditional forging establishments tend to be relatively unchanged.

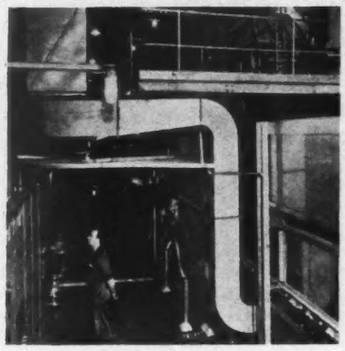
The growth of the forging industry has not been in direct relation to the growth of the automobile industry because the latter has introduced cheaper processes, such as fabricating, oxy-acetylene profile cutting, flash and butt welding and casting, wherever possible. It appears, though, that the practice of replacing forging with other processes has been carried nearly to the ultimate. In future, any growth in the motor industry should entail a proportionate growth in the demand for precision forgings.

It is anticipated that future demand for forgings for railway rolling stock will remain constant, but an increased demand is expected for the manufacture of agricultural machinery and for general jobbing. Indeed, general jobbing engineering, including plant and equipment maintenance, is still the biggest market, by weight, for the industry's products.

Advance in Canadian Brewing

Following research and development work over a number of years, Dominion Malting (Ontario) Limited of Toronto, Canada, a branch of Canadian Breweries Limited, claim to have evolved a process for making malt on a continuous flow principle. This process is said to be a significant advance on present conventional methods.

The engineering work for the process has been carried out by Robert Boby Limited, of Bury St. Edmunds (Suffolk, England) and the Vickers Group, who have built a commercial scale prototype plant and installed it in Toronto.



A section of the new continuous flow malting plant.

Comprehensive tests on this plant appear to have justified Dominion Malting's enthusiasm.

This new continuous-flow malting process has the advantages over more conventional methods of (*a*) reduced operating costs, (*b*) greater flexibility in operating control, (*c*) a considerable reduction in overall processing time, and (*d*) marked economies in construction costs. The world manufacturing rights are held by Robert Boby Limited.

Steelworks Projects in Australia

Orders for the design, manufacture and erection of (*a*) scree ore treatment plant, (*b*) basic oxygen steelmaking plant, and (*c*) a tinplate cut-up line have been placed by the Broken Hill Pty. Company Limited and Australian Iron and Steel Limited with Head Wrightson (Australia) Pty. Limited, a subsidiary of Head Wrightson and Company of Great Britain.

The scree ore treatment plant will handle 1,200,000 tons per year of scree deposits taken from the vicinity of Iron Knob and will have an output of 800,000 tons of concentrate averaging about 60 per cent iron content.

The order for the basic oxygen steelmaking plant is the first export order to be secured by a British firm for the supply of a complete plant using any of the new oxygen steelmaking processes. This plant, with an output of approximately 500,000 tons of steel per year, will be installed at Whyalla in Southern Australia. Head Wrightson are responsible for the supply of two basic oxygen furnaces together with the oxygen lancing equipment, fume ducting and fume conditioning gear, the steel plant buildings and various ancillary items.

The tinplate cut-up line is to be built to the designs of the Head Wrightson Machine Company Limited, of Middlesbrough, and is a copy of the line which went into production a few months ago at the Port Kembla works of Australian Iron and Steel. At first, this line will be used to enable steel strip up to 40 in wide and in coils weighing up to 45,000 lb to be cut up into sheets, suitable for hot dip tinning, at speeds of up to 800 ft per minute.

Near the entry end, and before the flying shear, flying micrometers and pinhole detectors will note sheets which are off gauge or have surface defects, and they will be automatically rejected by the classifying and piling device which is placed after the shear. The classifier built into the line is said to be the first four-pile flat-topped classifier with single sheet classification anywhere in the world. Eventually, this cut-up line may be used to take coils of electrolytically tinned steel strip and cut them into sheets of varying sizes to suit the requirements of the canning industry.

The engineering for the whole of this line, and part of the equipment, will be supplied by Head Wrightson, but the major part of the equipment will be manufactured in Australia.

The Sicard Snow Master

Ingenious invention and a rapidly expanding demand, due to present-day transport requirements, have combined to make Sicard's Canadian snowblowers world famous.

Fig. 1 Blowing snow on to lawns. Accurate casting makes it possible to miss the driveways.

THOUGH originally designed 33 years ago, the Snow Master snowblower is still a leader in its field. It is the embodiment of an original invention rather than the result of evolution from a traditional product, for snowblowers did not exist previously.

The Snow Master is an engineering product of some complexity that was invented and first designed without the benefit of a technical education by a Quebec farmer called Arthur Sicard. His success contained the usual ingredients of ingenuity, foresight and good luck, but in his case the contrast is sharp, the elements stand out clearly.

Quebec can count on some 8 ft of snow in a winter, delivered in a few big storms with a fall of over ten inches in a matter of 6 or 8 hours. Suddenly, a farmer is faced with having to remove about 600 lb of material from every square yard of roadway before he can get his dairy products to the market. If the snow is light, snow ploughs work fast and efficiently, but with every new storm the road bed is narrowed until the plough itself cannot pass. And if the snow is wet or a crust of ice has formed, ploughing becomes hopeless. Such were the problems of Sicard in the 1920's, when this ingenious French-Canadian began to search for a solution.

Effective snow removal and Sicard Incorporated of 2055 Bennett Avenue, Montreal, grew up together. Sicard's invention made it possible to *remove* snow economically instead of just pushing it into large piles along the road. Its success stems basically from a realization that heavy snow must be broken up before it can be moved, and that snow banks must not be allowed to accumulate at the sides of the roadway.

For his solution Sicard drew on experience with the automobile—already common enough in North America to be taken for granted—and farm machinery. He took two augers and mounted them horizontally one above the other. These were to break up the snow and feed it to a centrally located impeller, a descendant of the manure spreader, to be blown evenly over the adjacent countryside.

Sicard mounted his contraption on the front end of a truck. He recognized that his truck engine would have no power left to spare for the blower unit and that an auxiliary engine would have to be added. The only place for it was behind the cab on the truck's cargo platform, and an engine and long transmission were duly fitted. This addition restored the balance and traction of his machine which was teetering under the weight at the front.

THE FIRST SNOWBLOWER

The first snowblower was wheeled out of Sicard's workshop in 1925, and 36 years of experience and engineering have not resulted in any major change in the original and apparently haphazard layout. It suffered from a number of ailments which were corrected in the first production model, shown in Fig. 2. This unit was sold in 1927 to the City of Outremont, a suburb of Montreal and was in continuous service until 1952.

While Sicard was struggling to get his business started, important things were happening in the world around him which were to exert a decisive influence on his future. Millions of automobiles were swarming over the country, weaving an expanding web of roads from coast to coast. Maintenance of the road system gradually changed from a luxury to a national need.

In the cities people and cars were competing for living space, with cars winning the battle and leaving no room for snow. And people were fleeing into outer rings of suburbs, staking their livelihood on a system of streets that must be kept passable every day of the year. Then by 1930, the pioneers of air transport were experimenting with all-weather flying, in all seasons, under any latitude, and thinking of long clear runways for heavier and faster planes.

Thus Sicard's invention, which was sound enough in itself to be successful, was destined to become involved with the two commodities that had the greatest influence and the most spectacular growth in the first half of the twentieth century: the automobile and the aircraft. These circumstances combined to make Sicard's sales a continuously rising curve right through the depression to the present day, with an average annual increase of 10 per cent, or double the national average.

In the early years Sicard only built the snow blowing units; they were mounted on trucks manufactured by the Four Wheel Drive Company. Later it was realized that the use of a commercial truck chassis imposed certain undesirable limitations on the design, so in 1937 Sicard started to build their own chassis.

Like so many other Canadian industries, Sicard's company only came to maturity during the Second World War. Large fleets of heavy bombers and transport planes were to operate from northern airfields all the year round, and while other engineering shops had to retool to manufacture armaments, Sicard kept right on making Snow Masters for the air forces of the West. Their manufacturing facilities were considerably enlarged, and a new product was added to the snow removal equipment—airport maintenance trucks which utilised the Sicard chassis.

After the war further attempts were made to diversify the company's activities which suffered from the seasonal demand for its most important product. Refuse collecting machines and street washers were developed, not only making use of Sicard's truck chassis, but also taking advantage of the good will accumulated by the Snow Master with the townships and municipalities. Finally in the late fifties the Sicard chassis underwent a further metamorphosis and emerged as a line of heavy earth hauling trucks, cement mixers and other specialised vehicles.

In spite of the more recent additions, the backbone of Sicard's business is still snow moving. From 1937 to the present the original snow blower has been reintroduced in a variety of sizes and capacities, with literally hundreds of options from engine make to chassis length and a full line of accessories to meet a diversity of needs. In addition, truck mounted snowploughs, high speed snowblowers for airfield

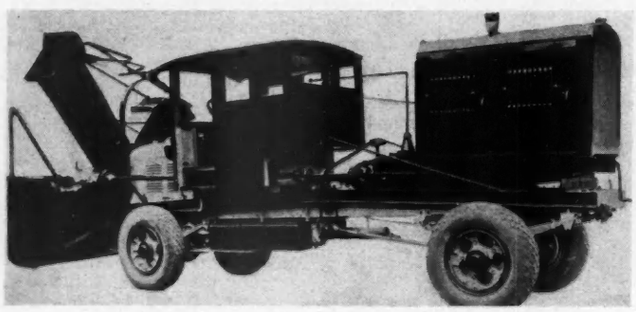


Fig. 2 Sicard's first production snowblower, vintage 1927.

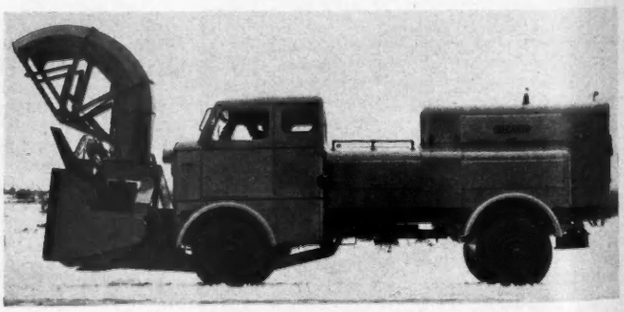


Fig. 3 Today's Snow Master. Its impeller casing is tilted for free discharge.

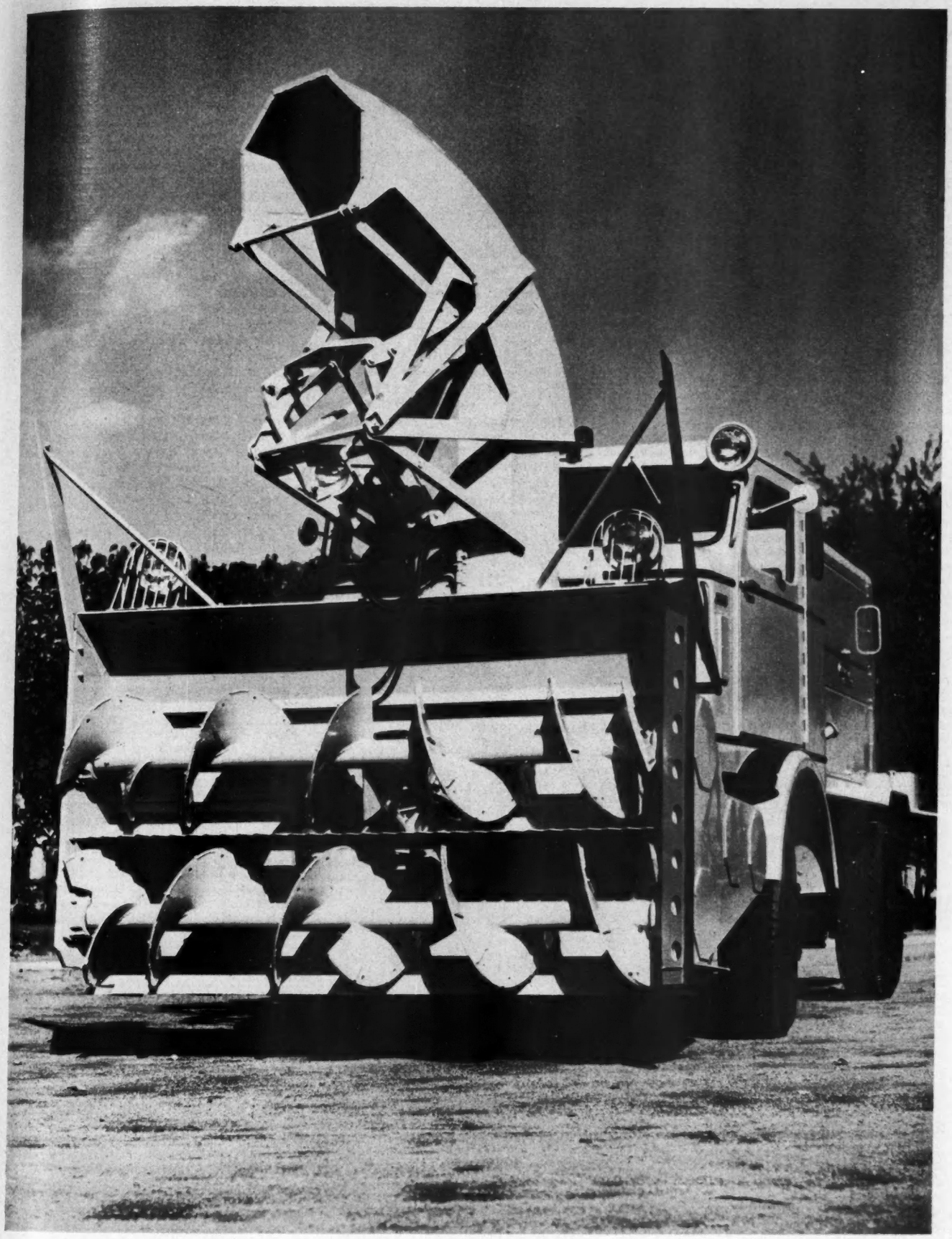


Fig. 4 A highly respected machine which sprang from a local demand and a simple idea.

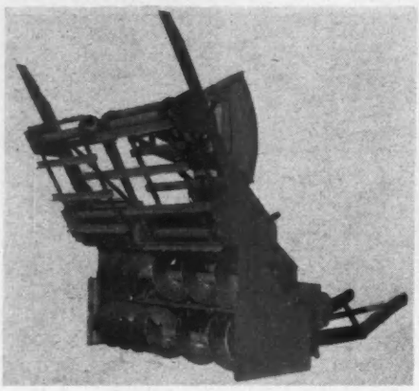


Fig. 5 For operating in deep drifts: a rake attachment to feed the augers.

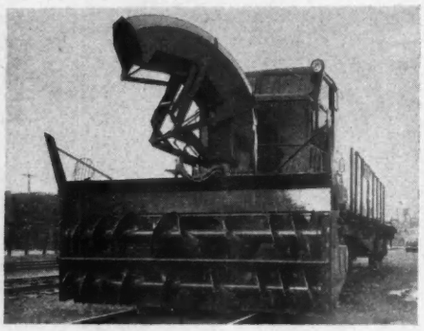


Fig. 6 An extra wide rail-mounted version.

service, and most recently runway sweepers for slush removal have rounded off Sicard's snow moving business. Figs. 5 and 6 show two of the many variations.

A snowblower must handle material densities varying from 6 to 40 lb per cu. ft, with snow depth varying from 2 to 100 in, interleaved with layers of ice, sprinkled with salt, sand, refuse and rocks, or soaked with water. Casting must be accurately controllable to meet the needs of loading into a moving truck, for depositing on to the front lawns of suburban houses leaving the driveways and windows clear, or for even dispersal over a strip some 150 ft wide. The required functions must be performed at high efficiency as operating costs play an important part in the purchaser's assessment of snow removal equipment.

SIMPLE SOLUTION

Sicard's mechanical solution is deceptively simple, but long experience has given the Snow Master a certain degree of sophistication. A startling feature is the recommended combination of a petrol traction engine and a diesel blower engine (though other combinations are optional).

The truck engine is rated at 150 bhp and geared 192 to 1 between crankshaft and wheels. The arrangement permits the delivery of maximum engine torque to the driven axles at speeds as low as 0·8 mile per hour. For travelling between work sites the five-speed gearbox and two-speed transfer box permit a maximum speed of 42 mph, or 33 mph with an optional gearbox.

Petrol engines are recommended for traction because of the large fluctuations in power and torque demands, and the long idling periods which are typical of truck loading operations. Fuel economy is the reason for choosing a 340 bhp supercharged diesel engine to drive the blower.

For economical snow removal the blower engine is governed to run at the speed of maximum power output. The operator drives the machine into the snowbanks at the maximum speed which the blower engine can accomodate without slowing down.

Fig. 7 shows the transmission arrangements, drive to the front end being taken through two propeller shafts in series. The snow impeller is shaft driven directly, while power for the twin augers is taken off by means of bevel gears and an enclosed 1¼ in duplex chain final drive. All shafts are protected by shear pins.

The two 20 in diameter augers are separated by a serrated feed plate and operate independently. Steel cutting blades can be bolted to the augers to assist in the disposal of caked ice or hard packed snow. From the augers the snow is fed to the impeller, which is essentially a centrifugal pump operating on suspended granular solids. Its casing can be rotated 45° either side about the impeller shaft. In the vertical position the impeller discharges into the loading chute, but when tilted either side the snow is blown out freely for dispersal over a wide area.

The loading chute can be rotated about the vertical axis and the chute hood raised or lowered to give accurate control of snow casting. When total snow removal is required—now standard practice in all city business districts—a truck is driven alongside the blower and filled through the chute. Fine control of cast permits loading the truck to its capacity; and the high discharge velocity ensures that light snow is compacted, with volume reduction often reaching 30 per cent, thereby minimizing trucking costs.

The blower frame, made of US Steel's Cor-Ten plate in ¼ and $\frac{1}{16}$ in thicknesses, rides on replaceable skates during snow removal, but can be raised about 11 in for travelling.

All blower controls are hydraulic and include raising or lowering the blower unit, tilting the impeller casing, rotating the chute and raising or lowering the hood. An optional feature designed to increase reliability is a dual hydraulic pump system, one driven by the traction engine and the other by the blower engine.

Experience has shown that for any snow density and depth there is an optimum combination of auger and impeller speed. Since snow conditions vary over such a wide range the Snow Masters are set for the best average, which varies from the Atlantic Provinces through the Prairies to the Pacific Coast.

Next year Sicard are planning to introduce an optional two-speed gearbox for the blower drive to broaden the range of maximum efficiency operation. At present the augers run at about 365 rpm, with an impeller speed of 425 rpm.

Although snow removal equipment is used for only perhaps 400-1,000 hours a year, when it is needed it must be serviceable and must be able to operate without breakdown under the most difficult conditions. As for any other emergency equipment, the customers' first requirement is reliability; next comes low operating cost; finally low first cost and long service life.

Total removal of snow ensures that streets and roads remain free of obstruction to traffic or parking at all times. Snow cannot be allowed to obstruct the way of fire fighting equipment or ambulances.

Canada's airports operate over 200 Snow Master units, and the US Air Force possess over 400. On important airports the runways must be cleared to black-top in about 30 min as jet aircraft—with low slung engines and poor starting thrust—cannot operate from a snow or slush covered runway.

Sicard are the first to admit that under certain narrow operating conditions almost any competing product may be more efficient than the Snow Master. What has made Sicard the standard for snow removal equipment at the Canadian Department of Transport and the US Air Force is the ability to operate under any conditions with the utmost reliability. As a guide to its ruggedness Sicard point out that the Snow Master's service life is around 20 years, probably a record for any present-day automotive equipment.

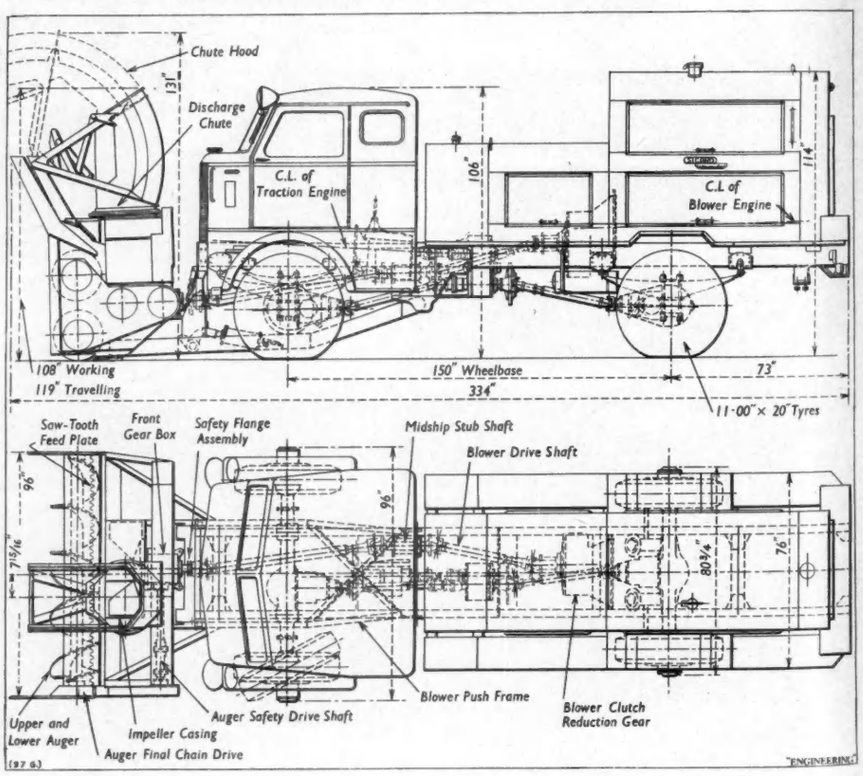


Fig. 7 Drawing showing the transmission layout from the traction and blower engines.

Marketing

New Zealand's Diverse Industry

NEW ZEALAND'S engineering industry was born in the earliest days of organized settlement when the colony's simple engineering needs were met by the blacksmith, the shipwright, and the millwright. The discovery of gold in both islands in the 1850's stimulated the development of engineering shops in the Otago Province of the South Island and in the Thames district of the North Island. The demands were feverish and the trade lucrative, so that fairly large engineering works with expensive plant were established to make ore-crushing batteries, boilers, steam engines, pumps, pipes, tanks, and to meet the general needs of large-scale quartz and alluvial gold mining.

During pauses in the manufacture of mining requirements these engineering works undertook other lines of manufacture, particularly those connected with the developing agricultural industry. The agricultural machinery industry was then in its infancy. Importation of implements was difficult and costly and much inventive ability and mechanical aptitude was displayed by New Zealanders in making and adapting farming implements to suit the country's requirements. New Zealand can claim to have initiated many of the ideas behind the design of such modern cultivation machinery as drain and stumping ploughs, chain and disc harrows, cultivators, seed sowing drills, and seed cleaning machinery. It is also thought that this was the first country to use large power-driven dredges to obtain gold from swamps and rivers. More than 200 dredges were built after 1863 and some were sold to Siberia, South Africa, Malaya, Western Canada and South America. The New Zealand design influenced the evolution of the gold dredge throughout the world. Other engineering equipment—timber jacks and log haulers, flax milling machines, locomotives and marine engines—were made after the late 1870's.

Advent of Refrigeration

The decline of the gold mining industry, the development of refrigeration and the advent of the internal combustion engine for industry and also of hydro-electric power had profound effects on the New Zealand engineering industry. It proved itself versatile and adaptable in meeting the demands made upon it. Many steam engines and small ships were built between the 1870's and the end of the First World War. The manufacture of oil engines was increasingly important from the turn of the century, but further development was arrested by expansion in the use of electricity after 1920. The agricultural industries expanded rapidly when refrigeration of perishable foodstuffs made it possible to sell meat and dairy produce profitably 12,000 miles away, and this expansion provided wide fields for New Zealand engineering. The growing demands of the dairying industry, particularly before 1914, afforded opportunities for the manufacture of prime movers, farm and factory butter churns, butter presses, milking machines, cream separators, and pumps. The larger butter churns were widely exported. At the same time the development of railways, roads and harbours in a mountainous country gave the mechanical engineers opportunities to make heavy transport agricultural, civil engineering and road making plant on a larger scale than ever before. The engineering industry was forced to invent equipment to meet special demands and to manufacture replacement parts which were as good if not better than the imported articles.

The New Zealand engineering industry was further stimulated by the First World War. Many freezing works were built, steamers were converted from coal to oil burning, marine diesel engines were installed in small ships, and much more construction plant had to be manufactured in the country.

Diversification between the Wars

Developments in the petroleum industry in the 1920's called for much structural and mechanical engineering in the establishment of bulk storage and distribution depots. The manufacture of steelwork for buildings and hydro-electric projects became an important activity.

During the Second World War the industry was able to produce a wide range of munitions as well as to continue manufacturing on a greatly increased scale, construction plant, machinery, and engines which were no longer procurable from overseas. The entire engineering industry was organized as a single unit for large-scale production. Shift work was introduced and State authorities were empowered to direct labour to engineering factories engaged on urgent war requirements.

Since 1945 New Zealand engineering has been called upon to carry out or assist in many very large projects, notably in the construction of several major hydro-electric power generating stations, in the establishment of two large pulp and paper enterprises, a long railway tunnel, a major port development, the Auckland Harbour Bridge, many steel framed buildings and steel bridges, and regional water supply schemes. Some of these works necessitated the setting up of joint venture associations or integrated heavy engineering units and this brought about a marked change in the character of the New Zealand engineering industry.

The future extent of employment for such large engineering organizations depends on the scale of public and local authority works and major private industrial undertakings aimed at developing the country's resources. The disciplines imposed by such demands have influenced the New Zealand production engineering industry in its efforts to produce goods for the New Zealand market.

Cost Advantage in Machine Tools

The industry has developed a tradition for the manufacture of capital equipment. Its workers have also shown an aptitude for making high quality items which are unsuitable for mass production and which require skill and ingenuity. The country cannot hope to match the major industrial nations of the world in volume manufacture, but there are opportunities for New Zealand to compete successfully in international markets in the production of speciality articles with a highly skilled labour content.

Overseas industrialists are finding that New Zealand can manufacture some types of machine tools more cheaply than in the larger industrial countries. Examples are fully automatic machines for the accurate sizing of piston rings, special types of oil filters for use in British and Continental cars in North America, electronic line-fault finders, hearing aids, and marine jet engines.

New Zealand's population is increasing at over 2 per cent a year. The country's industries must be greatly expanded and the economy strengthened and diversified in order to preserve the high living standard of its people. New Zealand must develop its resources to the fullest extent to reduce its dependence on the sale of a narrow range of primary proructs in fluctuating overseas markets. A sustained effort will be needed to conserve overseas earnings by importing the country's needs in the crudest form and applying New Zealand labour and plant to produce capital plant and equipment as well as consumer goods.

Swift Growth in Process Industries

The country is now in the early stages of another major move forward in manufacturing. Important industrial developments in progress include large expansions in the already large pulp and paper industry, in woollen milling, and in the carpet, food canning, fertilizer, building board, and plastics and cement industries.

New industries are operating or being planned for the manufacture of wallpapers, bulked synthetic yarns, window glass, cotton fabric, steel bars, rods and strips, copper and brass tube, sheet and strip, aluminium sections, wood screws, wires and wire ropes, chemicals,detergents, and weed killers.

An oil refinery to process imported crude oil is to be built shortly. Drilling exploration for oil is proceeding on a major scale. Negotiations are being made to increase substantially the New Zealand content of motor vehicles assembled in this country. New Zealand will see before long the establishment of a major aluminium smelter using the country's adequate hydro-electric capacity to process aluminium ingots from imported Queensland alumina. The establishment of an iron and steel industry based on New Zealand iron sands is also being investigated in detail.

Hydro-electric and Geothermal Moves

In addition there are major schemes to improve roads, harbours, bridges, aerodromes, to control large swift rivers and to develop great hydro-electricity stations, to harness geothermal energy, and to develop farm lands by large-scale operations using the largest available machines. All these activities will make heavy and sustained demands on the New Zealand engineering industry for the production of a wide range of equipment and for machinery calling for the exercise of imagination, initiative and skill in its design and construction.

The engineering industry in New Zealand is already quite extensive and covers the fields of consulting and civil, automotive, aeronautical, designing, diesel, electrical, factory maintenance, general mechanical and production, heating and ventilating, hydraulic, marine and precision engineering. In the four main centres of Auckland, Wellington, Christchurch and Dunedin there are some 100 precision engineers and about 470 general and production engineers. There are no separate statistics available for engineering workshops, these being included under the various groups dealing with metals, base metal manufactures, metal products, manufacture and repair of machinery and equipment, electrical machinery and appliances and transport equipment. There are in these groups 3,118 registered factories employing 45,110 persons.

In addition to these workshops there are the railway workshops and the naval dockyards employing some 5,874 persons and various municipal transport workshops employing 1,152 persons. Excluding the railway and tramway workshops, naval dockyards, bakeries, pastry kitchens, boot and watch repairers, abattoirs and all one man factories there were 8,565 registered factories within the manufacturing division of the New Zealand Standard Industrial Classification of all Economic Activities in the year 1958-59. These factories employed 168,772 people.

Many New Zealand workshops, in addition to the repair and maintenance of industrial plant and machinery, manufacture capital plant and machinery for other industries. They often have their own production lines to keep their organizations operating at full capacity as well as the labour, drawing facilities, machines, and managerial capacity to make fairly complex metal products.

New Adventures in Mechanical Engineering

High standards of fitting and turning, the small size of engineering shops, and the variety of the work require versatility and wide experience in such tradesmen as fitters and turners, toolmakers, patternmakers, moulders, boilermakers, and blacksmiths.

Future development in New Zealand's engineering industry will include increased manufacture of machinery and equipment for such activities as refrigeration, transportation, food preservation and packaging, goods handling, earth moving, and various branches of agriculture and dairying. New Zealand will manufacture for export goods based on domestic raw materials and a wide range of the products of New Zealand skill as applied to imported raw materials.

The next 20 years will therefore see a great expansion into new fields of mechanical engineering. New Zealand will develop to a much greater extent its ability and capacity to manufacture industrial machinery and equipment to the orders of customers both at home and abroad.

On the Shelf

By Frank H. Smith

I SUPPOSE there is some sort of one-upmanship in this business of inventing new technologies. I see that Terzaghi's soil mechanics of the middle twenties is now to be outmoded by the First International Conference on the Mechanics of Soil-Vehicle Systems, at Turin from 12 to 16 June. It must have been great to have lived in the days of Telford, when an engineer built a bridge or erected a building and made a road and knew they would still be there a hundred years hence. Nowadays they make a highly scientific job of it, with consultants at every step and stage and the awful worry that it might not outlast them. Which brings me to a contribution from one of my more regular " feeds " (no commission—just goodwill). He offers me a University of Michigan Press title by Bekker, *Off-the-road locomotion: research and developments in terramechanics.* He suggests this might be more appositely " terrormechanics."

The catalogue of Walter J. Johnson Inc., 11 Fifth Avenue, New York 3, contains 5,858 items in American and Foreign Periodicals they have for disposal in the fields of physical and natural science, including biology and medicine. These items are not, of course, single volumes by any means. There must be an awful lot of paper to dispose of, and the capital tied up in that lot gives me the shudders.

Butterworth's (4-5 Bell Yard, London, WC2) have a leaflet with a frightening contents list advertising the appearance of B. C. Vickery's *On Retrieval System Theory* at 30*s*. Retrieval is, of course, the U word which turns librarianship into a sort of gun-dog trial, and Vickery is the super-Cruft in this field. The back of the same leaflet announces a second edition of *Classification and Indexing in Science*. I'm not sure that that " in " should not be " as a."

If you care to drop a line to Mr. J. W. Tidswell, general sales manager of George Bray and Company Limited, Leicester Place, Blackman Lane, Leeds 2, he will see about mailing you some of the Bray literature. The particular sample I have is *Lights under Bushels*, which traces the development of the firm from the original George Bray in 1872 when he played about with gas burners. Acetylene lamps are not much used on bicycles these days. " The Gas Division Today," " The Insulator Division Today," " Electric Heating Division Today " and " Bray Accessories Ltd. Today " are headings of sections showing the firm's development.

If you want a catalogue of the books from Panstwowe Wydawnictwo Naukowe, drop a line to Ars Polona, Krakowskie Przedmiescie, Warszawa, Poland, and if the typesetter feels hard done by, let me tell him that I've left out a couple of accents at least.

Another service offered by this estimable journal (and they pay me to tell you) is " A and E," a rather crafty abbreviation for Articles and Events. This is a card, which is being periodically issued, giving as much of the editorial programme as can be forecast four to 12 weeks ahead. Frinstance: *I* know that to coincide with the Soviet Trade Fair, in London, 7 to 29 July, ENGINEERING will have a Soviet trade review in the issue of 7 July. Get the idea? It's owt for nowt anyway, so drop a card, or 'phone TEMple Bar 3663, and give me a boost while you are at it.

From the bulletin which Islington Public Libraries thoughtfully send me I see that a warm bath will in future cost a bob (a shilling to you Americans) instead of eightpence. But class distinction is cut out and you can have only one class bath instead of first or second. In the washhouse one tub and one horse used to cost a tanner (6*d* to you Americans) for two hours, and now one tub and two horses will cost 6*d* an hour. What's all this horse business? Shades of Gilpin I suppose.

Wind of Change—or Whirlwind

The African Revolution. By JAMES CAMERON. *Thames and Hudson.* (18*s*)

Which revolution? Would it be called a revolution if a railway built across equatorial Africa happened to create, almost as a byproduct, an entirely new colony? If, in the space of forty years, the inhabitants of half a million square miles in the upper Nile basin saw their country transformed from misery to prosperity and independence, would that be regarded as a revolutionary change?

Engineers are entitled to ask these questions, for they know quite a lot about revolutions and can regard them with detachment, no matter whether in a jet engine there may be fifteen thousand revolutions per minute or in a South American republic less than half a dozen revolutions per century. Only personal choice determines whether or not a rate of change is high enough to be deemed revolutionary. Many people are so passionately drawn to whatever is new or exciting or revolutionary that if the London buses were suddenly to be painted green, they would proclaim a revolution in London Transport. In this frame of mind, who would trouble to choose between words such as " transformation " or " revolution "?

Equally is it a matter of opinion whether social and political revolutions are necessarily more earth-shaking than technical revolutions. Here again it seems to be chance that allots the term or withholds it. How odd it is that although the Industrial Revolution and the Railway Revolution are familiar concepts, yet, despite the revolutionary effects of electrical dicoveries and developments from the time of Michael Faraday to the time of Sir Christopher Hinton, we never hear of the Electrical Revolution.

Reading now what Mr. Cameron has to say about the African Revolution, we realize at once that neither he nor his publishers are in any doubt whatever. They are looking for revolutions. This book is intended to be one of a series describing the Great Revolutions—those major upheavals that have been turning points in human history.

Do current events in Africa fall within this definition? In regard to the speed with which they follow one upon the other, that can be gauged by remembering some other quite recent books about the one-time Dark Continent: *Inside Africa, Terre qui Meurt, Twentieth-century Continent, Hope in Africa.* The matter is beyond question. Here is indeed a revolutionary rate of change. It is so fast that it has baffled so experienced a journalist as Mr. Cameron. He speaks of the chagrin that " besets the man who tries to record the movement of a vast historical process that is in full development before his eyes, that shifts and changes and eludes him as he seeks to fix its pattern." Nevertheless he and his publishers have kept hard on the heels of events: in a book published in January of this year, the arrest, even if not the death, of Mr. Lumumba is recorded.

But do these tides of opinion and the rise and fall of personalities constitute in their bewildering variety an African Revolution? Only, as the author admits, if he is allowed to mould his material pretty forcefully into the pattern he has in mind. He says that " to find a political affinity and a common base or purpose today between North Africa and the great land mass behind it is an act of faith."

Readers might themselves regard the book as a *tour de force.* In less than two hundred pages, Mr. Cameron has described the emergence and the triumph or denial of nationalism in all the regions between the Mediterranean and the Cape of Good Hope: this combination of historical information and brilliantly written comment is journalism at its best.

Because he is such a good reporter, the author is sparing in the use of italics, so when they do occur we can be sure they are intended to have a special significance. One such italicized word is *demand.* A passage at the beginning of *The African Revolution* runs: " Africa is legend, fact, mystery, promise, threat and enigma. Above all today it is *demand.*" This word will strike home to engineers with a particular depth of meaning. They may not know what interpretation Mr. Cameron expected. They may be astonished that a man writing about revolutionary changes in Africa should never mention the Kariba dam or the Owen Falls plant or the projected Volta river scheme. It is such names that remind engineers of the innumerable demands they have already met.

They remember the roads and harbours and railways and bridges they have built in Africa during this 20th Century. From personal experience they know that engineering colleges in Great Britain have resorted to every expedient so that African students could be accommodated, while other Africans come as FBI trainees to our engineering workshops and civil engineering works.

No doubt, Mr. Cameron might say. But under the influence of the revolutionary mood he exposes so convincingly, the demand might become far more intense. It cannot be met, he implies, by a mere evolutionary expansion of existing facilities. There must be an upsurge of revolutionary ardour on the part of the suppliers to match the exhaltation of the receivers. Will it be enough to think of the Wind of Change, or must we prepare for a whirlwind?

It will certainly not suffice to talk only in terms of geological formations and axle-loads and prices and prestressed pipes. Names and influences and sympathetic insight may be more important—names like Nkrumah and Nyerere and Banda and Lumumba, and what they stand for.

Mr. Cameron need not fear that we shall forget his own name, nor the confident way in which he has carried out his task: his book can indeed serve as " the simplest of guides to the most complex of contemporary happenings—the African Revolution, in which many men have found their feet on earth at last, breaking a path for those who follow. It is a daunting task, bearing the seeds of hope, and fear."

HERBERT ADDISON

Engineers Welcome Down Under

Migrant Australia. By J. M. GILES. *Mills and Boon.* (12*s* 6*d*)

This book is intended to be a quickly absorbed introductory guide to life in Australia, and it is certainly no more than that. Within these limits, it is successful.

The author has a distressingly staccato style but it represents the genuine vernacular—a little dated perhaps but in the best traditions of men " on the track." The colloquial approach is that of the old character lecturing you across the sliprails, unsophisticated, discursive, not always accurate on minor details, honest but faintly aggressive.

Perhaps it is on account of its honesty that Mr. Giles's book could be recommended to the intending migrant. He does not gloss over the difficulties which may be encountered, although he appears to understate the number of people who may be deterred by the difficulties. There are more than 1 per cent who, for some reason or another, do not like the new land they have come to. Official figures show that 6 per cent of British migrants return, but it must be added

that for most the alienation is only temporary (and often caused by compassionate family reasons). Two-thirds of the returning migrants eventually go back to Australia again, this time at their own expense, leaving a net loss of 2 per cent. There are damped oscillations by third and fourth-timers that do not significantly affect the figures. One wonders whether there are contemporary Flying Dutchmen forever sailing back and forth in a fever of uncertainty.

Engineers will not obtain a very clear idea of their employment prospects from the chapter entitled "Finding a Job," for the author has understandably avoided precision in the shifting sands of employment possibilities. He has outlined the attitude with which a migrant should go looking for work, rather than examined the prospects of various occupations or professions. The rapidly expanding nature of secondary industry has caused a general shortage of engineers ever since the war and even in periods of recession, employment prospects for engineers have been notably better than in some other Commonwealth countries. However, in such times the migrant might do well to avoid the extremities—Perth and Queensland—which is a pity for they are probably the most pleasant places in which to settle. This remark is, of course, unavoidably general and depends on his specific profession. Mining engineers, for instance, may well find these places to be the most rewarding.

The chapter title "Culture and So Forth" indicates Mr. Giles's attitude in this matter. He is firmly among the middlebrow group to which he correctly claims the preponderance of the nation belongs. There should be no "reaching down into the gutters," as our playwrights may so regrettably have done, and there should be no worshipping of classics without question. Nonetheless, this chapter neatly illustrates the difficulty of maintaining a distinctive national culture, developed in times of isolation, through an uncertain future of ever-tightening communications and overwhelming, internationally syndicated ad-mass values. Paradoxically, Australia is becoming predominantly a land of big cities and the essentially cosmopolitan influence of the modern metropolis is beginning to show.

Between these pages, a personality is fixed which the migrant to Australia will meet many times.

A. KELLOCK

Technical Education Emerges in Nigeria

University College Ibadan. By J. T. SAUNDERS. *Cambridge University Press.* (22*s* 6*d*)

Some three years ago there appeared a book *The Birth of Nigeria's University* by Dr. Kenneth Mellanby, the first principal of University College, Ibadan. This was a stimulating account by the central figure in a pioneer development of how a new university college, the first in the "newly-emerging" territory of Nigeria, was literally "carved out of the bush" in six years from 1947 with degree courses running and students in residence.

In the present book Dr. J. T. Saunders, the second principal (1953-56), a distinguished don and administrator of one of our older universities, reviews the history, development and activities of University College, Ibadan. Its publication coincided with the celebration of the independence of Nigeria.

Dr. Saunders describes the evolution of education in Nigeria in the Western pattern with particular attention to the activities of the Christian missions long before government schools were set up, and to the generally meagre provision and progress up to 1939. The Elliot and Asquith Commissions were sent to West Africa by the British Government in 1943 and resulted in the siting of the University College for Nigeria at Ibadan, the largest "African" town in Africa, and the formation of the Inter-University Council in the United Kingdom. The University of London agreed to a form of special relationship with the new University Colleges, whereby London degrees would be awarded and the local staff given experience while participating in the examinations and establishing local standards.

The decision of the Nigerian Government to disperse high technological training throughout Nigeria by setting up the Nigerian College of Arts, Science and Technology at Zaria in the North and Enugu in the East as well as at Ibadan—also arising from these Commissions—was criticized in some quarters as making development more difficult. This was probably so, but nevertheless the effect has been to accelerate the spread of higher education throughout Nigeria. Dr. Saunders' account reflects to some extent the general view which emanated from UCI in his time that it alone in a population of some 35 millions should be responsible for all education in Nigeria to graduate level, and especially was this so in engineering. The Nigerian College, however, carried on with the task allotted to it and for which funds were provided.

Descriptions are given of various foundation days, design and architecture of the college, the library, students' accommodation, the faculties, the teaching hospital, and Royal visit and examinations. The volume ends with a series of appendices, among them the College Ordinance, admission procedure, Register of Undergraduates from 1948, and a list of honorary associates and graduates.

The first institution of higher education in Nigeria was the Higher College, Yaba, set up in the 1930's, which was closed down in 1948 on transfer of courses to UCI. The excellent civil engineering course at Yaba was terminated at that time. If a serious effort had been made to remove the distrust of Yaba by Nigerians caused by the failure to ensure that they could secure a qualification recognized outside Nigeria and the technological courses started there continued, the hiatus while the Nigerian College was getting under way could have been avoided.

Dr. Saunders does not mention a parallel body to the Inter-University Council set up in the United Kingdom under the aegis of the Colonial Office—the Council for Overseas Colleges of Arts, Science and Technology—concerned with the Colonial development and welfare aspects of professional and technological education. By 1959 the Nigerian College had received for engineering and other professional courses over £1 million from the British taxpayer as well as some £3 million capital grant from the Nigerian Government.

The reader is left ignorant of the overall British contribution to higher education in Nigeria (see "The Technical Foundations for Nigeria," by C. A. Hart, ENGNG., vol. 190, 1960, p. 442) and Dr. Saunders in expressing his views does not bring out the needs of professional education in Nigeria where no professional cadre had existed before 1945 (except a few medical men and lawyers trained overseas). No mention is made of the professional courses instituted in NCAST between 1954 and 1958 for example in architecture, land surveying, estate management, pharmacy, accountancy, public administration, fine art, and so on—all of them recognized or associated with the appropriate professional institutions in England or by UK universities.

The present writer recommended in 1949 that a Faculty of Engineering be set up. The Nigerian Government, however, in consultation with the UK Government, decided that professional training in engineering should be undertaken in the Nigerian College, and it still is. The Faculty of Engineering was physically located in NCAST in 1958 and its students became eligible for the B.Sc. (Eng.) London and generous help and guidance was received by the Nigerian College from the Institutions of Civil, Mechanical and Electrical Engineers, as well as from the University of London in this respect. Dr. Saunders wrongly refers to studies in engineering leading to the B.A. degree of London.

Dr. Saunders mentions as a disadvantage hat the Nigerian College when set up did not conform to any known pattern in the UK, but this general pattern was that of the Colleges of Advanced Technology introduced into the UK some three years afterwards.

The long-term policy of the Nigerian College (as accepted by the Nigerian Government in 1954) was to provide academic training for professional qualifications, the Federal and Regional Governments catering separately for technical institutes and trade centres.

Whether the present tendency in Nigeria to fragmentation, which is emerging in higher education since Independence is desirable before standards are fully established is doubtful. Unfortunately those who judge by our own settled and traditional pattern often fail to understand that in Nigeria (as well as other newly independent countries) higher education, which represents a considerable proportion of the national budget, becomes a political pawn, and political considerations often outweigh academic desirability. The "wind of change" in Africa has a tendency, alas, to blow away caution and commonsense, but it is to be hoped that the foundations so well laid by British effort will remain.

This book provides a useful reference text of the historical development of education in Nigeria, of the setting up and development of UCI and a record of its students. The absence of a bibliography, however, is unfortunate. Dr. Saunders' account should be read in the context of UCI and not as a complete account of the balanced development or needs of higher education in Nigeria as a whole and particularly of the technologies. That story still has to be told.

C. A. HART

Compatibility of Preferences

The Commonwealth and Europe. *Economist Intelligence Unit Limited, 22 Ryder Street, St. James's, London, SW1.* (42*s*)

The British Commonwealth Year Book, 1961. Edited by RONALD S. RUSSELL. 9th edition. *Newman Neame Limited, 50 Fitzroy Street, London, W1.* (63*s*)

Recently the *New Statesman and Nation* published a Vicky cartoon on Britain's entry into the Common Market. The bridegroom, a reluctant Mr. Macmillan, was seen apprehensively leading his plump complacent Germanic looking bride labelled "Europe" up the aisle. President Kennedy, wearing a coonskin cap with shotgun at the ready, followed a few steps behind, while President de Gaulle, with Chancellor Adenaeur standing by approvingly, showered the advancing couple with confetti.

The cartoon may have been closer to reality if de Gaulle had been depicted throwing fistfuls of sharp, lethal tacks in the path of the couple and, perhaps, if Mr. Maudling had replaced Mr. Macmillan, who should have been marching

behind the shotgun instead of Mr. Kennedy.

A few months ago the possibility of Britain joining the Common Market seemed remote. Today, however, all the good Europeans among our journalistic commentators are baying to be in at the kill. Nicholas Davenport in the *Spectator* congratulates the Prime Minister for adopting, during his recent tour of the United States, a monetary theory Mr. Davenport has been advocating for years. Henry Fairlie in *Time and Tide* slates Mr. Macmillan for being hesitant about abandoning a system that Britain has painfully built up over 200 years on the grounds that you can now buy *Spaghetti Bolognese* in Bolton.

It is therefore not inopportune that the Economist Intelligence Unit should produce *The Commonwealth and Europe*, a study of the effects Britain's membership of the Common Market might have on Commonwealth trade, commissioned by Britain in Europe. This work, together with *The British Commonwealth Year Book 1961* used as a reference, provides an excellent means by which industrialists, bankers and economists can keep abreast of trends in Commonwealth trade.

The Commonwealth and Europe contains comprehensive information on the Commonwealth's exports to Europe, including Britain the Common Market and the Outer Seven. The effects that a divided Europe, and the effects that various forms of association between Britain and the Common Market from a Free Trade Association to full membership, might have on these exports are analysed in detail. The argument is couched in terms that can be understood by any intelligent layman and supported by detailed appendices and diagrams.

Commonwealth trade, this study shows, has been declining over the past thirty years and the trend is liable to continue, but it will remain substantial for the foreseeable future. The pattern of this trade is being less and less affected by Commonwealth preference.

The advantages that Commonwealth trade would gain if Britain entered the Common Market and exerted a liberalizing influence on import policy are considered to be greater than the disadvantages caused by loss of preferential treatment in the British home market which such membership would entail.

Only 8 per cent of British and 6 per cent of EEC imports of Commonwealth raw materials would be affected by integration and the gain from the higher rate of growth resulting from integration would far outweigh this loss.

Trade in Commonwealth manufactures, apart from low cost Asian producers, should present no great problems. The problem that Asian Commonwealth manufactures face is not tariffs, which do not present insurmountable barriers, but quantitative restrictions, and here Britain could be expected to exert a liberalizing influence on the Community.

The great stumbling block is agriculture. It is argued with both temperate and tropical foodstuffs that lack of integration may block the Commonwealth from a potential market of great value, while terms could be arranged in any agreement so that Commonwealth foods would not suffer unduly. But there seem to be a great many "ifs" in this argument. At present integration seems to threaten Commonwealth temperate foodstuffs that can be produced in Europe. The threat to Commonwealth tropical foodstuffs due to EEC discrimination in favour of associated overseas territories (even today Guinea, after breaking off all connections with France, still retains these advantages) is even greater. This discrimination could affect two-thirds of the Commonwealth trade in tropical foodstuffs with Europe. But Britain would, no doubt, attempt to secure the same advantages for Commonwealth tropical foodstuffs enjoyed by the overseas territories.

Apart from temperate and tropical foodstuffs and Asian manufactures it would seem then that integration would present no great problems to Commonwealth trade. But why should the Common Market desire British participation? It would make EEC a bigger market; prevent trade dislocation arising out of the split between the Six and the Seven; and provide Europe with substantial advantages in Commonwealth markets if Britain had to abandon—as she surely would—the preferential treatment given to her in these markets.

The work concludes with the following sentences, "The task of this book was not to answer these political questions, but to find out whether the economic problems created in this context by Britain's relationship with the Commonwealth can be solved. The conclusion is that they can."

But the question is, above all, a political one. Will Britain's integration in the Common Market produce the same psychological fillip to production as it has in existing Common Market countries? All these countries were overrun and conquered during the Second World War and are therefore willing to abandon part of their sovereignty to become part of a larger whole to ensure it does not happen again. Britain was never in this position.

W. V. HARCOURT

Guide to Dominion Markets

CABMA Register of British Industrial Products for Canada, 1960-61. 8th edition. *Published for the Canadian Association of British Manufacturers and Agencies by Kelly's Directories, and Iliffe.* (15*s*)

The Canadian market, partly from emotional reasons, holds a special place in this country's export drive. It is nearer than Australia and next door to the United States. We feel that if we cannot sell in Canada we cannot sell anywhere abroad.

Its opportunities, its particular requirements as a market, the seemingly endless flow of trade missions and trade goodwill tours in each direction, and not least the importance of this country as a market for Canadian wheat, keeps the external trade position with Canada ever before our eyes. In an illogical sort of way we feel that if imperial preference went overboard tomorrow there would still be plenty left to keep the Canadian market open to British goods. The impression is given too that, numerous as the shortcomings may be of the British sales effort in the Dominion, we sell harder and better there than in most countries.

At the present time there is particular interest in the Canadian market. So far as this country is concerned, the need for a general export drive was never greater. On the Canadian side, the economy is passing through difficult times owing to balance of payments problems. The heavy investment, especially from the United States, which has for some time given outstanding strength to the Canadian dollar has eased off, partly at Canadian instigation.

Canada is worried about the burden of the service on United States debt obligations, the outflow of profits and the control which foreign capital (again notably in the United States) has gained over Canadian industry. Such a climate of opinion is not unpropitious for British goods. Canada is one of the places in the world where the local business community and all that goes with it are less suspicious of the British than of someone else. The call is to get in and sell.

The CABMA Register is now in its eighth edition. It is published for the Canadian Association of British Manufacturers and agencies who are managers of the British Trade Centres in Toronto, Vancouver and Montreal. It is a practical guide to over 3,000 British products available in Canada, with suppliers' names given under each heading and equivalent headings in French. A list of nearly 4,000 British concerns includes details of their distribution arrangements in the Dominion.

Not only is the Register useful to Canadians but it shows British companies who are already in the market and the kind of coverage they offer. It should be part of the trade literature collected by all who are about to tackle this market really systematically for the first time.

G. E. TEWSON

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical Power

Flameproof Remote Control. BELMOS CO LTD., Bellshill, Lanarkshire. Type RCS remote contro station for automatic contactor starters and the like. Flame proof for groups II and IIIa gases; rated up to 650V a.c. Leaflet 2 pp. ill.

Contactors. LONDEX LTD., 207 Anerley Road, London SE20. Contactors types BC and LC with ratings up to 20A at 250V a.c. or 15A at 440 a.c. using silver contacts; two and four pole versions, operating coils for up to 600V a.c. or 250 d.c. Leaflet 166/D, ill.

Circuit Breaker Load Centres. BRYANT ELECTRIC Co., Box D, Barnum Station, Bridgeport, Conn., USA. Circuit breakers for distribution systems rated up to 200A at 240V a.c. Single and three phase types for assembling in groups. Catalogue C 200. 20 pp., ill.

Control Board Components. GENERAL ELECTRIC CO. LTD., Erith, Kent. Components for control boards and mimic diagrams; selector switches, semaphores and lights. Technical bulletin 403; 16 pp. ill., with diagrams.

Non-Standard Equipment. NELSON ENGINEERING Co. LTD., Netherfield Works, Nelson, Lancs. Examples of non-standard electrical equipment include hetrapolar motor, plug-in and high voltage transformers and instruction items. Brochure 10 pp., ill.

The Reviewers

Mr. Herbert Addison, O.B.E., M.Sc., M.I.C.E., M.I.Mech.E., is a consultant and author with special interest in hydraulic engineering. From 1921 to 1951 he was lecturer and professor in hydraulics and hydraulic machines in the faculty of engineering, Cairo University. He has made a special study of irrigation and land reclamation projects in various parts of the world. His books include *Land, Water and Food, Sun and Shadow at Aswan, Applied Hydraulics* and *Rotodynamic Pumps*.

Mr. Alan Kellock, B.Sc.(Melb.), A.M.I.E. (Aust.), joined the Australian Post Office 20 years ago and is currently stationed in London as liaison engineer for the United Kingdom and Europe. He also holds the Diploma of Public Administration (Melb.) and was for three years full-time general secretary of the Professional Officers Associations.

Dr. C. A. Hart in 1949, professor of civil engineering in the University of London, visited Nigeria by invitation to advise on the introduction of degree courses in civil engineering and land surveying at the proposed college in Ibadan. Later, after a period as vice-chancellor of India's first technological university at Roorkee, he became principal (subsequently rector and principal) of the Nigerian College of Arts, Science and Technology, a complementary institution to the University College of Ibadan. In that position Dr. Hart was responsible for building three colleges of technology, one in each Region of Nigeria and for introducing and developing professional education in Nigeria, excluding medicine.

Mr. W. V. Harcourt is overseas information officer in the Federation of British Industries. A former journalist, he still contributes from time to time to the *Guardian*, the *Spectator* and the BBC.

Mr. G. E. Tewson, who graduated from Glasgow University in Economics, is a partner in the firm of O. W. Roskill, industrial consultants.

Low-Level Weather Probe

A cloud-scraping television tower near Dallas, Texas, is now doing double duty as the world's tallest meteorological research structure, the USAF Air Research and Development Command announced recently.

Rising 1,428 ft above the Texas plains, the structure contains twelve platforms at heights from 30 to 1,420 ft with instruments to automatically measure and record winds and temperatures.

The tower has been equipped for meteorological measurements by the Electrical Engineering Research Laboratory of the University of Texas, under contract with the Geophysics Research Directorate of the Air Force Cambridge Research Laboratories. Part of the cost of equipping the tower was contributed by the Army Signal Corps.

Principal object of this project is to investigate a weather phenomenon known as the "low-level jet," explained Dr. M. L. Barad of the Geophysics Research Directorate, who has overall technical responsibility for the programme.

"This important feature of the atmospheric boundary layer consists, in its fullest development of a sharp maximum of wind speed at an average height of 1,000 to 1,500 ft above the earth's surface," said Dr. Barad. "At the level of the maximum, the wind speed often reaches 50 or 60 mph, accompanied by much lower values both below and above this level.

"The jet develops after sunset, gradually increases in intensity until a few hours after midnight, and then shows a gradual decay until shortly after sunrise."

The project was promoted by the marked effect of the low-level jet on air force operations, coupled with a Signal Corps need for related meteorological data. Aim of the programme is twofold: to acquire a better understanding of the processes involved in the jet and, if possible, to develop a forecasting technique.

Data-gathering stations are located at twelve levels, between 30 and 1,420 ft. Information from these stations will be fed into a precision analogue computer built by Electronic Associates Incorporated, the American counterpart of Electronic Associates Limited, Burgess Hill, Sussex. The data which the computer receives from the wind and temperature-sensing instruments is digitized for processing and analysis. In addition, plans are being made to mount and operate fast-response instruments capable of measuring atmospheric turbulence at several tower levels.

The triangular tower was originally built as a cooperative venture by two television stations to support transmission antennae. It was selected for instrumentation by the Air Force Cambridge Research Laboratories after a survey of towers of heights exceeding 1,000 ft. Use of the tower was offered by the television stations on a no-cost-to-the-government basis.

Improving Timber Quality

As a first step to selective breeding in timber cultivation, specimens of wood taken from trees grown in various parts of Britain are being examined by radio-isotope methods at the DSIR's Forest Products Research Laboratory. The apparatus developed for this purpose (which was recently displayed at a conversazione held by the Royal Society at Burlington House) is completely automatic and micro-scale measurements of density which would formerly have been a very laborious process can easily be made without human intervention, by measuring the transmission of beta particles (electrons) through a thin specimen of wood.

Density is probably the best single measure of timber quality. In this connection, variation within the individual growth rings, as well as the overall density of the wood, has to be taken into consideration. Samples are obtained by means of a tool similar to an auger. A microtome is then used to cut sections 100 microns thick, and these are mounted on a plastic slide for examination.

The method makes use of a radio-active isotope (carbon 14) as the source of beta particles, an anthracene crystal, a photomultiplier, and an electronic counter. Many of the beta particles are absorbed, the number depending on the density of the wood. Each beta particle which passes through the specimen produces a flash of light as it emerges and impinges on the crystal. The flash of light, directed on the cathode of the photomultiplier, releases electrons, which, at the next stage of the photomultiplier, release more, until an appreciable pulse is built up. An electronic amplifier further magnifies the output pulses, whose rate is then registered on a counter. The variation of density in the specimen as it moves automatically through the beam can thus be recorded on a graph, and when the operation is complete, the instrument is automatically switched-off.

The Forestry Commission has begun its survey by taking samples from some 180 Sitka spruce trees growing in parts of Britain as widely separated as the North of Scotland and the south coast.

Softwood is the timber trade's principal material in this country, and Sitka spruce has been chosen because it is the most extensively planted tree in Great Britain. The trees selected for examination are those whose growth has been extraordinarily successful, and DSIR is investigating samples from these trees to decide how far genetic factors are responsible for their condition.

Developed jointly by two DSIR laboratories and the UKAEA, Harwell, this apparatus automatically measures the density of wood samples.

Satellites for International Communications

Based on their very extensive experience of space communication vehicles, International General Electric of New York Limited have just put forward a plan for a world-wide communications system of ten earth satellites, to be launched with international cooperation. As a first step, the company's recently created subsidiary, Communications Satellites Inc., has sought a multimillion dollar US Government subsidy and has invited commercial investment to bring technical ability and operating experience together. Seen as an enterprise backed, but not controlled by the government, an international consortium of companies is envisaged which would own a ring of satellites. These would be able to relay telephone, telegraph, television and business data signals from one earth point to another.

The ten satellites, each weighing 1,000 lb and 25 ft in largest overall diameter, would be "active" in principle—relaying and not merely reflecting the signal. They would be 10,000 miles apart from each other, at an altitude of 6,000 nautical miles—an optimum height for avoidance of echo interference—and would take 6·33 hours to orbit the earth. A five-year useful lifetime for each would be aimed at, with one month for accurate placing. Final positioning accurate to $\pm$ 5° Greenwich meridian would be by rocket motor situated on the satellite itself.

Frequencies have been allocated of 6,000 megacycles for ground to satellite, and 4,000 megacycles from satellite to ground. Some form of amplitude modulation for frequency stacking of individual channels would be incorporated. Past research has shown that there would be no interference with earth stations, and shut-off mechanisms would prevent any interference with the system from a faulty satellite in orbit.

The system would operate initially with 18 earth terminals, but 100 terminals are planned by 1970. Television transmission time would be one half-hour per day to start with, and this would be adequate, it is thought, for average long-distance interest coverage. Requests have been made for 1,200 voice channels and one television channel per satellite.

Maximum transmission coverage of the earth in one stage is a function of ground latitude and is greatest at the equator, where it would reach one-quarter of the earth's circumference. It follows that launching from a region at or near the equator—as at Cape Canaveral—is an optimum measure.

With five successful firings out of ten allowed in cost estimates, each satellite would cost $3½ million, including launching, and booster rockets would cost $8 million each, including failure allowance in orbit. The completed system would cost some $250 million.

The scheme is regarded as having immense possibilities, as far greater use would be made of its higher quality, more readily available and eventually much cheaper service. It is technically acceptable to the GPO, conceptual differences alone remaining.

The details affecting ultimate acceptance of this ambitious system would be considered by the International Telecommunications Union Convention, which is itself, appropriately enough in the case of a multi-nation enterprize, an agency of the United Nations. International General Electric anticipate agreement on all basic proposals by the end of this year, and plan to put the system in place in 1964 following test launchings in 1963.

Woomera's Optical Range

The Weapons Research Establishment in South Australia tests many types of rockets and missiles. Situated in a semi-desert, the WRE are able to make full use of optical techniques for much of their measurement work.

With the increasing complexity of modern missile systems, testing involves much more than simply firing a representative batch at a target and counting the score. In fact, to cover anything approaching a representative batch of missile and target conditions would be economically impossible. Therefore, missile test programmes are conducted largely by simulator studies, and actual missile firings are carried out only under very closely controlled conditions, first to provide parameters for the simulator studies, and later to check the reliability of the simulator work by detailed comparison of actual firings with simulated firings.

From this it follows that the missile test range must do much more than just launch the vehicle. It must somehow measure its behaviour and the detailed performance of parts of its various internal systems. This must be done to the precision necessary to make the measurements useful to the missile sponsor. The upper atmospheric research rocket will telemeter to the ground information on the appropriate phenomena that its internal instruments have been designed to detect; but this is not enough. It is also most important to know where the missile is at a given moment.

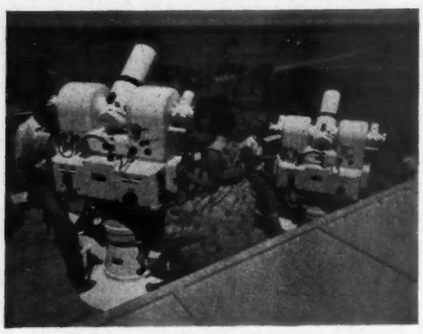
Trajectory information is therefore required and must be related to the same time scale as the internal instrumentation. The attitude of the missile may also be needed to determine the orientation of internal instrumentation. With a military missile, in addition to telemetering to the ground a large number of its internal parameters, it must have them related to external measurements which provide information on the outcome of the changes that have occurred in the propulsion system, guidance system, etc. Trajectory, velocity, accelerations, attitude, and the final flight path in relation to the target must therefore be determined.

Range instrumentation for this purpose can be divided into two broad categories, electronic and optical. This does not imply that electronic instrumentation has no optical components or optical instrumentation no electronic components; on the contrary, most of the instrumentation is so integrated that neither could operate without the other, but the broad division into electronic and optical can still be used.

Woomera is situated in semi-arid desert country. Its number of essentially cloudless days is quite high and the water vapour content of the atmosphere is low. These conditions provide excellent visibility, which makes the exploitation of optical instrumentation attractive. The optical equipments used include: complete units that are commercially produced for missile range use; integrated installations utilizing commercially available components together with components developed at WRE; and instruments developed entirely by WRE and manufactured there or by local firms.

Phototheodolite and Ballistic Cameras

These are most accurate angular measuring instruments used on the Woomera range. The principles of operation of the two devices are very similar. The optical axis remains stationary while multiple exposures are made on a photographic plate. The field of view is reasonably wide, varying from about 30° to 50° included angle, and permits a satisfactory portion of missile trajectory to be covered. A missile which is simultaneously reocrded by two cameras located at the ends of a surveyed base line can obviously have its position fixed by simple trigonometrical calculation. The main difference between the phototheodolite and ballistic camera is that the former has precision theodolite scales related to the direction of its optical axis. This enables the instrument to be set up without including reference objects in its fields of view. The ballistic camera has only coarsely graduated scales and relies on photographing suitable reference objects to determine its direction.



Typical double kinetheodolite installation.

Both these systems are used mainly at night, and the stars provide a convenient high-accuracy reference. The missile can be made to emit a series of programmed electronic or pyrotechnic flashes. The camera shutters are opened just prior to the first flash and closed when the series has been completed. The photographic plate then records a series of dots representing the flashes, and short lines representing star trails; the trails being caused by the rotation of the earth during the exposure. Alternatively the missile can carry a continuously burning flare and the cameras be equipped with chopping shutters. These break up the trail image of the flare to permit time correlation.

For daylight use, the orientation of the phototheodolites can be correctly set using the precise scales. Ballistic cameras require either ground reference objects to be included in the field of view or alternatively the installation to be very rigidly mounted and sufficiently stable to ensure that calibration at night by star background can be relied upon for day use. This stability is of the order of 1 second of arc, and involves an elaborate installation and airconditioning to close temperature limits. Light from the sky will rapidly fog the plate, and to avoid this a manually controlled tracking blind, with a narrow slit which follows the missile, can be incorporated to reduce excessive sky exposure. Another method is to heavily filter the lens to reduce sky exposure, and arrange for the missile to emit a number of high intensity flashes.

At present, a number of phototheodolites and ballistic cameras are installed at sites spread over a wide area. More than one equipment is necessary at each site to provide adequate sky coverage.

The phototheodolite used is the Swiss-made Wild BC4, which has an angular measuring accuracy of 3 seconds of arc. It is fitted with either an 8 in f4 or a 12 in f2·5 lens with respective fields of view of 44° and 32°. The instrument theodolite scales can be read to better than one second of arc.

The ballistic camera used at Woomera was developed at the Weapons Research Establishment. It has a 7 in f2·5 lens with a 52° field of view. As it relies on star background to determine precise orientation, the scales are only accurate to 1°. The angular measuring accuracy is 10 seconds of arc.

Kinetheodolites

These are next in order of measuring accuracy; they are the main optical "work horse" of the range. Unlike the phototheodolite, the kinetheodolite is a tracking instrument, its optical axis not being fixed, but following the missile under the control of its operator. A series of photographs of the missile is taken, each of which includes records of the elevation and azimuth angles of the optical axis. A graticule with cross lines intersecting at the optical axis is also recorded. If the missile is not being tracked accurately at this intersection, correction can be made from the known calibration of the lens. The instrument system is designed so that all equipments on the range take their pictures simultaneously, and as a result, any two kinetheodolites situated at the ends of a known baseline can provide a series of successive "fixes" of the missile, from which trajectory and velocity can be found. As kinetheodolites are fitted with quite long focal length lenses, up to 60 in, the missile image size, except at extreme ranges, is large enough for its apparent attitude to be measured relative to the graticule lines. Such data from two instruments enables the missile's true attitude to be determined. When missile/target aircraft interception trials are conducted, the trajectories of both missile and target aircraft are needed. To meet these requirements Woomera has a number of double kinetheodolite sites, one instrument tracking the missile, the other the target aircraft.

Two types of kinetheodolites are used. The first 5 miles of the range are covered by German-made Askania kinetheodolites. These are aimed manually by the operator and take pictures at the rate of 4 per second. The lenses are either 40 in or 24 in focal length. 35 mm film is used and the film magazine provides a 3 minute running time. The overall angular measuring accuracy of the instrument is better than 30 seconds. The range's main kinetheodolite system, however, utilizes a Swiss-made Contraves instrument. A number of these equipments are installed down the first 50 miles of each flank of the range. As already mentioned most of the sites have two instruments to cater for interception trials.

The Contraves kinetheodolite has a power-operated control system providing the operators with a simple and accurate means of tracking the missile. Input from the range acquisition system can be accepted, and is used to servo operate the instrument independently of its human operators when the missile is too far away to be seen in the sighting telescopes. Once the operators have acquired the missile they take over control as their tracking accuracy is superior to the remote system. The film transport mechanism has two operating speeds,

Research Report

on the work of the

Mechanical and Optical Techniques Group, Weapons Research Establishment, Department of Supply, South Australia.

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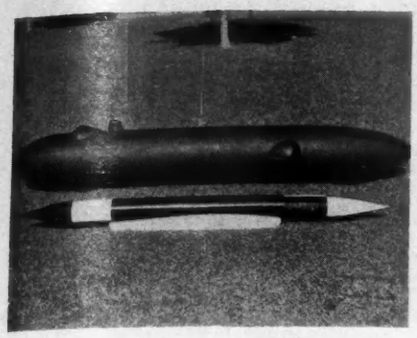


WRE camera pod, with two 180° field of view cameras, compared with earlier pod containing four 150° field of view cameras.

20 and 40 pictures per second. Standard 35 mm cine film is used, and the magazine provides 5 minutes running time at 20 pictures per second and 2½ minutes at 40 pictures per second. The focal length of the lens is 60 in. With interpolation, the records of the theodolite scale can be read to 4 seconds of angle. The overall angular measuring accuracy is better than 15 seconds.

The angular measuring instruments referred to above are designed and manufactured to very precise limits both optically and mechanically. The azimuth and elevation axes must be mutually perpendicular to less than 6 seconds, the optical axis must be normal to the elevation axis to the same order of accuracy. The instrument must be levelled to three seconds. It must be constructed so that physical loads imposed by the operators or the instrument's own movements do not upset its accuracy; nor must this be affected by a wide variety of climatic conditions that can be met on the world's missile ranges. These are but a few of the problems faced by the designers. The range has, of course, the task of maintaining this precision instrument under inhospitable field conditions, and it is a credit to both the designer and the user that these equipments have already given many years of accurate service.

Performance Cameras

These are not angular measuring instruments; their purpose is to obtain high-speed detailed pictures of the missile for qualitative assessment, and to provide in-flight attitude data. To obtain the necessary large missile images very long focal length lenses are used, the longest at present being 200 in. To record high-frequency behaviour, a fast picture repetition rate is required This is normally in the range from 50 to 300 frames per second, but higher speeds, 1,000 to 2,000 frames per second, are also sometimes used. A 200 in focal length lens recording on the standard 35 mm cine film format has an included angle field of view of only 15 minutes. The operator must not only track the missile accurately enough to hold it within this field, but must do so steadily, to ensure that the missile image does not jump from one side of the frame to the other, with resultant blurring caused by the relative motion of the image during exposure. To provide this accurate tracking, a power operated camera mount was developed at the Weapons Research Establishment utilizing components from fire control radars. Facilities for remote "laying on" by the range acquisition system are incorporated.

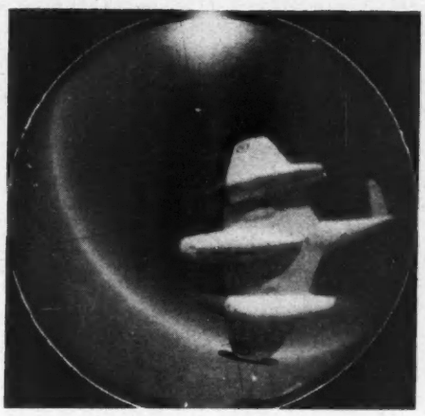
A number of performance cameras are concentrated within a short radius of the launchers for recording details in the early flight stages. Additional installations extend down the first 50 miles of each flank of the range, and isolated equipments are positioned further down range. The standard 35 mm camera used is the British made Vinten HS 300, which operates at speeds up to 300 frames per second. Facilities are incorporated in the camera for recording ruler or elapsed time code signals. A number of mounts carry other higher speed cameras in addition to the Vinten.

The optical instruments so far described are the main ground systems at Woomera but, in addition to these, much use is made of airborne and missile borne systems.

Target Aircraft Cameras

These are used to obtain the flight path of an anti-aircraft missile with respect to the target aircraft and also their relative attitude. This system uses photographic triangulation from two groups of cameras installed on the target. If each group has a spherical field of view, missiles approaching in any direction can be recorded. The groups can be separated by the maximum convenient baseline, normally the wing span.

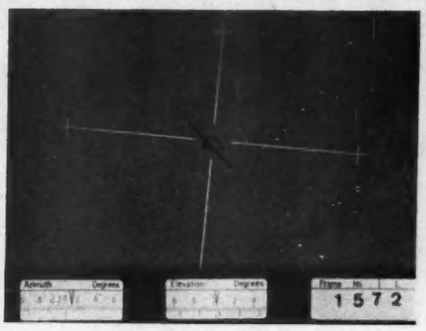
Systems based on this approach were first developed in Britain and the USA and utilised special cine cameras with fields of view in the region of 150° included angle. Four cameras were arranged so that their focal planes lay one on each surface of a tetrahedron, thus providing spherical coverage. The camera groups were normally accommodated in a streamline wing tip pod. A successful installation of this type, using a camera developed by the Royal Aircraft Establishment, was introduced at Woomera some years ago on the Australian Jindivik target aircraft. However, since the size and weight of the pods represented a performance penalty



Target aircraft taken by WRECISS mounted in the intercepting missle.

on such a small aircraft, it was decided to investigate means of reducing aerodynamic drag and weight. To cut down the number of cameras per pod from 4 to 2 required a lens with 180° field of view. The development of such a lens was undertaken at the Weapons Research Establishment, and the final product was a two component lens with a field of view of over 180° solid angle and an aperture of f8. The large field necessitated deliberate distorion, which was arranged so as to provide a linear relationship between the angular position of the object and the linear displacement of the image. As the lens is used for obtaining angular measurements this is a convenient feature. Concurrently with the lens, a camera was designed to fit into a streamlined pod of minimum diameter. The final result was an aerodynamically clean pod of 5½ in diameter. This represented a decrease in frontal area of 80 per cent, and a decrease in weight of 60 per cent. This target aircraft camera, known as Weapons Research Establishment Target Aircraft Recorder (WRETAR), has been in use for some years and several hundred have been manufactured for the Weapons Research Establishment by a local firm, Fairey Aviation Company of Australasia.

The cameras use 35 mm film with a format size of 1 in diameter. The optical axes can be accurately aligned to aircraft datum by the use of precision reference faces on the cameras. The normal speed of operation is 100 frames per



Contraves kinetheodolite record, showing the instrument's azimuth and elevation.

second and the exposure time 1 millisecond. The maximum continuous running time is 20 sec. Timing signals from the range central timing unit are transmitted to the target aircraft and recorded on the film. The cameras are switched on and off by radio link from the trials control centre. A more recent high speed version of the camera runs at 170 frames per second; this reduces the time of operation from 20 to 12 sec.

The system gives an overall accuracy in the measurement of missile "miss distance" of ± 5 per cent for distances up to five times the camera group separation. Missile attitude can be obtained from the relative attitude of the missile image on individual camera records.

WRE Camera Interception Single Shot

Known as WRECISS, this is an airborne instrument unique to the Woomera range. It is a very small camera, for installation in anti-aircraft missiles to record miss distance and relative attitude between missile and target at the instant the proximity fuse operates. It thus provides data on missile and fuse performance. The results can be used in conjunction with information on warhead performance to indicate the lethality of the interception. It should be noted that warheads are seldom fitted for normal missile trials.

The WRECISS system had to be made sufficiently small to be readily installable in missiles which can seldom find more than 3 or 4 cu. in of suitable spare space. It also had to provide a spherical field of view, and operate in a time equivalent to the explosion of a warhead. By using the hemispherical field of view lens previously mentioned, only two cameras were necessary to provide the required coverage. Each unit was designed as a cylinder of 1·5 in dia and 1·2 in long and this satisfied the size requirement. To obtain the right order of delay between the initiating fuse signal and mid-exposure, the shutter was operated by a small explosive charge triggered by the fuse. This delay time is 0·5 millisecond and the effective exposure time 0·3 millisecond. A single picture is taken on a 1 in diameter format. The cameras are built robustly so that the intact film record can be recovered from the missile wreckage. Graticule and stadia lines are provided for measurement purposes and reference faces for aligning the cameras to missile axes. As the target aircraft is roughly cruciform, its image on the WRECISS photograph provides the direction of camera sightlines to suitable points on the aircraft. Vector miss distance can be calculated to 5 per cent of the distance, and relative attitude to 2°. This camera system was developed by WRE, and the Australian Fairey Company, who are also marketing them under licence in Europe and the USA.

This short description has only covered some of the main features of the more important optical instrumentation systems at Woomera.

The author of this report, Mr. R. P. Bonnell, is indebted to the Chief Scientist, Department of Supply, Australia, for permission to publish.

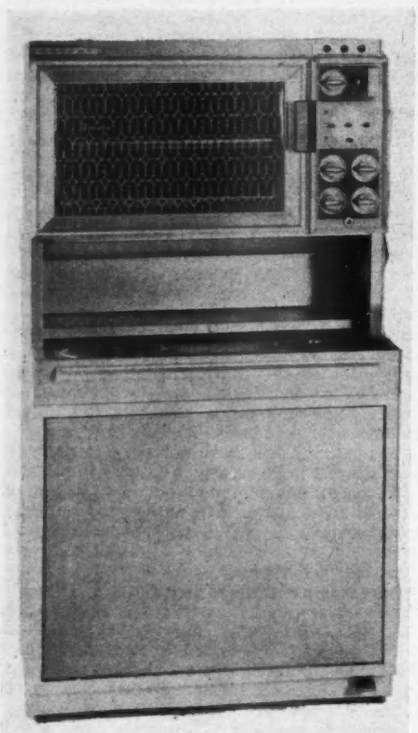
Canadian Style

AMONG the more elaborate of the cookers being produced for Canadian homes is the latest addition to the Moffat range, the Fiesta model illustrated.

Moffats Limited are an Avco of Canada company with a London address at 35 Davies Street, W1. The range of cookers that they produce is large and includes separate hob and oven units as well as more conventional types having four-ring hobs mounted above the oven. All incorporate timer control for the oven, and in some it is extended to control the roasting spit and one hot plate as well.

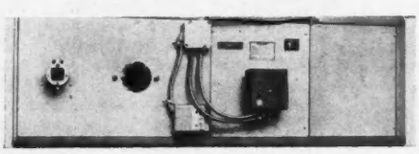
The Fiesta unit includes most of the equipment to be found on other models. It can be mounted on a " Lazy Susan " base as shown or direct on a wall. In either case the oven section comes level with the eyes and the hob is below it. The oven has a glass door extending the full length and has provision for installing a Rotisserie, the drive for which is in the control panel on the right. Immediately below the oven is a thermostatically controlled warming shelf and under that is the draw-out hob.

The " Lazy Susan " base is designed for storing pots and pans plus other cooking accessories. The shelves are fixed to the door and swing out as the door is opened so that all the articles are easily accessible. There is provision for holding a roll of paper tissues.



(*Left*) *The Fiesta cooker has swing-out storage in the base and the oven is at eye level.*

(*Below*) *Both gas and oil fired models of the McClary-Easy air heaters are available.*



In the closed position of the hob only two of the hot plates are accessible, one of which is governed by a heat control switch of the Simmerstat type while the other is fitted with a thermostat control. This latter plate can also be operated through the timer enabling boiling, simmering or frying to be maintained for a chosen period starting at a chosen time. The two rear plates are only exposed when the hob is pulled forward and have standard " Dial-a-heat" switches; there is an interlock so that the rear plates cannot be switched on unless the hob is in the forward position, and which also automatically switches them off when the hob is pushed back. All hot plates have pilot lights.

The warming shelf is deep enough to take 10 in diameter dinner plates and rugged enough to take pans straight from the hot plates. It is thermostatically controlled to maintain a temperature of 150° F and extends the full width.

There are several features connected with the oven which are outstanding. It is thermostatically controlled and the start and stop of cooking can be set on the timing clock. The Rotisserie is arranged to stand on the lower shelf with the drive shaft connecting with the motor in the control panel. It also is time and temperature controlled. An additional control is the Roastmeter, which is a thermometer probe for inserting in the meat to measure the temperature at the centre and give warning on the buzzer when the joint is done. The desired degree can be set on a dial so that underdone, well-done, or medium can be chosen according to taste.

The exclusive feature of the oven, however, is the control for the shelves. The lower is fixed at the bottom, but the upper is moveable to suit the height of the joint and the degree of broiling desired. Unlike most shelves, however, the movement is not by hand but is operated by power from a push button on the control panel. This allows very exact positioning of the roast or the grill, and adjustments can be made while cooking is taking place, the movement being observed through the glass door.

The second illustration shows one of the McClary-Easy air heaters for gas or oil firing. These are made by General Steel Wares Limited, who have factories at Toronto, Montreal and London (Ontario), and an English office at Regina House, 259 Marylebone Road, London NW1. The company also make cookers which rival the Moffat range, barbecues for camps and picnics, refrigerators and washing machines. At present they have two coin-operated laundries working in this country (one in Walthamstow and the other in Grangemouth), and there are plans to make up the number to 500.

The internal design of the heaters varies slightly to suit the different requirements of gas and oil firing, but the same external appearance and dimensions are maintained. The products of combustion pass through the heat exchanger, and air drawn in from the living areas passes over the outside thereby being heated. A humidifier and filter are included in the circuit so that the air is returned cleaned and with a suitable moisture content to avoid the parching effects of a moving stream of hot dry air. A feature is the indicator that shows by a red light on the thermostat unit when the filter is becoming clogged and needs attention.

Air circulation is provided by a fan which is linked with the temperature of the air. As a result when the burner first lights, the fan runs at slow speed and as the temperature builds up the speed is increased to give full benefits of the furnace output. When the burner switches off the fan continues to run at slow speed until the circulating air cools down to ambient temperature, when it cuts out automatically. It is particularly claimed for this arrangement that it prevents layering of hot and cold air through the house and also avoids the impression that the moving air is cold merely because it is moving fast. Several sizes of heater are available, and both vertical free-standing models as well as horizontal wall fixing types.

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